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THE MOUNT EVEREST EXPEDITION

AT the meeting of the Society on 10 January 1921, the President made the following announcement:

"At the meeting of November 8 I stated that there were then political obstacles in the way of our proceeding with preparations for the expedition to Mount Everest. Those obstacles, I am glad to say, have now been removed. Colonel Howard Bury, who went to India last summer on our behalf, was able to put our proposals before the Government of India with such persuasiveness that Mr. Bell, who is now in Lhasa, was instructed to ask from the Tibetan Government permission for us to send an expedition to explore Mount Everest. And we have just heard from the Secretary of State for India, who throughout has been most sympathetic to us, that the permission has been given.

"The political obstacles are therefore removed, and the Alpine Club and our Society will now organize an expedition which will have as its object the ascent of the highest mountain in the world—a mountain to which even the approaches are as yet unknown to Europeans. Such an expedition must be essentially a great adventure. High risks will have to be run and severe hardships endured—risks from icy slopes and rocky precipices and such avalanches as buried Mummery's party on Nanga Parbat twenty-six years ago; and hardships from intense cold, terrific winds, and blinding snowstorms. In addition there will be the unknown factor of the capacity of a human being to stand great exertion at a height more than 4000 feet higher than man has as yet ascended any mountain.

"The expedition will therefore, as I said, be a great adventure. But for the consolation of those who are never happy unless they can dub an expedition 'scientific,' I may add that it will be in the highest degree scientific also. For we may take it as certain that the summit of Mount Everest will never be reached unless we have first explored with the greatest care all the approaches to it through country at present entirely unknown; and then examined, mapped, and photographed the mountain itself in fullest detail. We must know all we can about the country around Mount Everest, about Mount Everest itself, and about the climatic conditions which prevail in that region. Our geography of it must be complete.

"In the present year the Alpine Club and our Society propose to organize a reconnaissance party to acquire this geographical knowledge. Next year we will send to Tibet a climbing party to apply it in a great effort to reach the summit.

"We hope that the reconnaissance party may cross into Tibet when the passes open, about the end of May, so that all the best part of this year may be available for their preliminary work. The final plans will then be made for the full assault upon the mountain in 1922.

"We have been assured of the cordial co-operation of the Government of India and more particularly of the Surveyor-General, who by great good fortune happens to be Colonel Ryder, who was chief surveyor officer with the Tibet Mission in 1903–4 and has seen Mount Everest at a lesser distance than any other European. With this assistance and with the aid our two Societies can give we believe that this expedition will start under better auspices than have favoured any other attempt to scale a high Himalayan peak. We mean to secure the very best men to be had; give them every advantage we can; then trust them to pioneer the way to the loftiest summit of this planet. And when that has been reached man will have taken a further big step towards the mastery of his surroundings."

A joint committee of the Royal Geographical Society and the Alpine Club has been formed to organize the expedition. Lieut.-Col. Sir Francis Younghusband (President), Mr. E. L. Somers Cocks (Treasurer), and Colonel E. M. Jack represent the R.G.S.; and Prof. J. Norman Collie (President), Captain J. P. Farrar (Past President), and Mr. C. F. Meade, the Alpine Club. The President R.G.S. will be President of the Committee for the work of the first year, and the President A.C. for the work of the second year. The Secretaries R.G.S. and A.C. will act as Secretaries to the Joint Committee.

At the meeting of the Society on January 24 the President announced that the Joint Committee had appointed Colonel C. Howard Bury to be Chief of the Expedition, and Mr. Harold Raeburn to lead the mountain reconnaissance this year.

The paper read to the Society by Brig.-General the Hon. C. G. Bruce, and published in the January number of the *Geographical Journal*, with the discussion following the paper, gives a full account of our present knowledge and lack of knowledge of the mountain, and indicates the lines upon which the reconnaissance will be made and ascent will be attempted. In the present number we publish some observations by Lieut.-Col. Howard Bury on the approaches to the mountain; and all further news of the organization and progress of the expedition which it is possible to give will be published from time to time in the *Geographical Journal* and the *Alpine Journal*. Brief announcements will also be made by the President

R.G.S. at meetings of the Society, and by the President A.C. at meetings of the Club. These will be communicated to the Press in advance, so that all newspapers may have an equal opportunity of publishing authentic information on the morning following any such announcement. No exclusive arrangements will be made with any newspaper or magazine, and no information will be given in any other way either by the Joint Committee or by individual members of the committee or of the expedition. The Committee will, in short, use their utmost endeavour to secure that the chronicle of the expedition shall be well considered and accurate; and no credence should be given to any statements other than those published by their authority.

A first estimate of the cost of the expedition shows that it will be necessary to raise a sum of not less than £10,000 to provide for the work of two years, and the President appeals to Fellows for subscriptions.

A VISIT TO BOKHARA IN 1919

Major F. M. Bailey

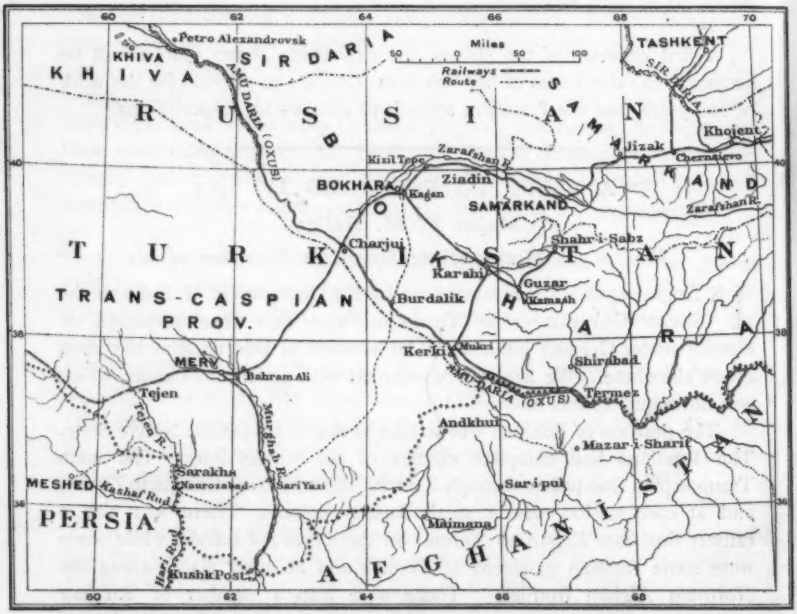
Read at the Meeting of the Society, 22 November 1920.

IN August 1918 a mission was sent by the Government of India to the Soviet Government of Turkistan, who were then suspected of coming under German influence. An account of this mission has been given elsewhere. We are now concerned with a visit to Bokhara which was the sequel to this mission.

The position of Bokhara was similar to that of an Indian Native State. The Russians had complete control of the railway lines. The main Transcaspian line passes through Bokhara territory from Charjui to Ziadin, and at each station was a small Russian colony. There was also a railway line from Kagan to Termez on the Oxus *viâ* Karshi, while there were some Russian garrisons at Termez and at other places along the Northern Afghan frontier. There were also a number of Russian business people in Bokhara city. The population of Bokhara consists of Mohammedans, with a few Jews in the cities. The population is entirely monarchist. When the Bolsheviks first came into power they imagined that they could revolutionize the whole of Turkistan. There was a small band of ruffianly Bokharan subjects, most of whom had been forced to leave the country, who styled themselves the "Young Bokhara Party." These people got into touch with the Bolsheviks and led them to believe that they had a large following in Bokhara. Flushed with their first success, the Bolsheviks imagined that their ideal of World Revolution was at hand and decided to lend a helping hand to their neighbours.

In February 1918 Kolisoff, a former oiler on the railway, and at that time Chief Kommissar, who has I believe since been shot for embezzling

money, took a force down the railway from Tashkent to Kagan, the railway station for Bokhara distant about 10 miles from the city. From here he sent an ultimatum to the Amir requiring him to accede to the demands of the young Bokhara party within twenty-four hours. The Amir, whose foreign relations had always been in the hands of the Russians, had no idea how to deal with such a situation, but sent some equivocal reply; Kolisoff remained with his force at Kagan, but sent some delegates to discuss the matter with the Amir. The next day a disturbance broke out near Kagan between the Red troops and some Bokharan subjects in which lives were lost. The news of this rapidly reached



Sketch-map of Russian Turkistan

Bokhara city, where the people rose and massacred all Russians in the city, including of course Kolisoff's delegates. The trouble then spread throughout the State, and all Russians along the railway lines and some of the small garrisons on the Afghan border were killed. The railway lines were taken up, and the lines to Karshi and Termez have never been repaired. The Bokhara army is of the most inferior quality, and it has always been a puzzle why Kolisoff did not at once move on Bokhara instead of retiring to Kizil Tepe station some 17 miles off. Here a treaty was signed by Kolisoff and the Amir's reprentatives on 25 March 1918, by which the Bolsheviks recognized the complete independence of Bokhara.

BOKHARA CITY, WITH THE TOWER FROM WHICH CRIMINALS WERE THROWN

THE "ARK" OR CITADEL, BOKHARA

CITY WALL OF BOKHARA

WATER TANK IN BOKHARA CITY

This success on the part of Bokhara made them over-confident that the Bolsheviks were afraid to attack them; and their whole dealings with the Soviet Government of Turkistan reflected this success, whereas the real reason that the Bolsheviks did not attack Bokhara was the fear of arousing a *jehad* among the Mohammedan population of Central Asia.

From this time the Russians maintained a residental at Kagan in the same way as before the revolution, the chief difference being in the personality of the resident. Instead of the old-fashioned Russian official who never was out of uniform, the agent (a man named Pechatnikoff) had in pre-revolutionary days made a living by hawking lamps in Bokhara city. The Bokharan Government kept a representative in Tashkent, but the Bolsheviks were very desirous that he should have nothing to do with foreigners.

The situation between the Bolsheviks and Bokhara was naturally always very uncertain. The Bokharan monarchy feared that another attempt would be made to install a revolutionary government; while the Bolsheviks, who were fighting against their enemies in Transcaspia, always had a feeling of insecurity with the possibly hostile State in their rear and on their lines of communication. What exasperated them most was the certainty that a very small force acting with determination could polish off Bokhara, and the only thing that deterred them was the fear of rousing hostility among all the Mussulman inhabitants of Central Asia, including Afghanistan, who all look with some veneration on the fanatically Moslem state of Bokhara.

The whole of the north of Bokhara is desert and steppe, with the exception of the oasis watered by the Zarafshan river, which flows through Samarkand and finally loses itself in the sands west of Bokhara city. The position of Bokhara is very much dependent on the neighbours upstream, who by damming up the river and flooding the area between Samarkand and Bokhara, could rapidly starve the city and oasis and force the government to accept any terms demanded.

The hilly south-eastern part of Bokhara is thickly populated and could make a long stand, but it is probable that with the loss of the city the prestige of the government would suffer such a blow that the State would break up. We shall soon see whether this is so, as the latest news is to the effect that the city has been captured by the Reds.

After having lived a year in Tashkent, in the autumn of 1919 I decided to leave, and succeeded in getting employment in a branch of the Bolshevik Secret Service. The Bolsheviks were very anxious to get accurate information about affairs in Bokhara, and had great difficulty in doing this, as their spies were frequently caught and drastically dealt with. One man brought them information that a whole regiment of Indian troops was hidden in a village surrounded by a cordon of Bokharan soldiers, whose duty it was to prevent the news of their presence leaking out. My duty was to obtain news of this and other matters.

We left in a goods-wagon one morning and reached Samarkand in something under forty-eight hours. Near Samarkand the train passes through a gorge where Tamerlane in the 14th century caused an inscription to be carved. The Russians on their conquest of the country also carved an inscription surmounted by an Imperial Eagle. The Bolsheviks have destroyed the Russian memorial as being too reminiscent of their Imperial days, but have left Tamerlane's inscription. In Samarkand we were told that our train would go on at 9 a.m.; but knowing a little about Soviet Russia I calculated that we should be quite safe to leave the train till 10; this gave us time to pay a hurried visit to the ruins of Tamerlane's capital, and we rushed round with a camera and took a few photos, but the early hour with the low sun and the necessity for secrecy forced us to take views frequently from unfavourable points of view. One of the large minarets in the Registan is in danger of falling and is held up by wire. I found that we had hurried quite unnecessarily, and our train did not go on till the evening.

Our travelling companions on this part of our journey were a party of Afghans, three small traders and three soldiers who were taking messages to the Governor of Mazar-i-Sherif and to the Afghan Consul in Bokhara. These men called themselves an Afghan Mission, and bluffed the railway authorities into giving them special accommodation on the train. They told us that the Afghan troops had occupied Peshawar, Attock, Lahore, Delhi, and were approaching Bombay.

We reached Kagan, the station for Bokhara, in the early morning. Bokhara city is about 10 miles north of the main railway line and connected to it by a light railway, which however was not running. I was here in the character of a Bolshevik secret agent working against Bokhara, and it was necessary for me to obtain permission from the Bokhara authorities to enter the town—a very difficult matter had I been a genuine Bolshevik. I had provided myself with a private letter saying I was a poor Austrian prisoner who wished to go to Bokhara city to make some purchases, and the true Bolsheviks considered me very clever to be able to get this permit in their interests.

We went to an hotel at Kagan, but it was full. While there a typical incident of life under the Bolsheviks occurred. A party of Red Guards from the secret police arrived, and removed a man from one of the rooms; we found out that he was himself a spy but had told some friends so, and this had got round to his employers, who would doubtless deal severely with him.

Stopping in the hotel was Mahendra Partab, a noted Indian revolutionary who had been living in Berlin most of the war. I had a long and interesting talk with him in German. He believed I was an officer prisoner of the Austrian army who had been captured early in the war. He made a curious statement regarding our rule in India. I asked him how it was that when we had the English nearly beaten in the war we

received no help from the 300 million oppressed people of India, on whom we had counted for considerable support; not only this, but we gathered that these Indian troops were fighting valiantly for the English on all fronts. He replied that that was a matter which he had often been asked to explain. The fact was that a victory of the central powers would have resulted in a Mohammedan Empire of some sort being established to replace the British, as Germans and Austrians were not people who had much success in such matters, and this would have been more oppressive for 220 million of the population than the present rule. I then asked him if no Mohammedan troops had fought for the English. He said that there were a few from the ignorant and uncultured frontier tribes.

A curious thing happened in Kagan. We received a telegram in cipher from Tashkent asking us to make careful inquiries about "Colonel Bailey of the Anglo-Indian Service." To this we sent a reply calculated to put the Bolshevik authorities off the scent.

After one night in Kagan I left for Bokhara, driving the distance along an execrable road. I had great difficulty in entering the city gates, and was kept some hours waiting in a tea-house at the gate.

I lived in Bokhara for about two months. Many Russians and some Austrians who had fled from the Bolsheviks were also living there. There were also some of the chief Mullahs from Tashkent and other places who had been obliged to fly from the atheistical Soviet Government.

The bazaars are most interesting. There is a special Jewish quarter and a Hindu Serai, where about twenty-five Hindus were living. They are all small traders and moneylenders, and are found in most large cities in Western Chinese Turkistan, and at Osh, Andijhan, and several cities of Russian Turkistan besides Samarkand and Bokhara, but they do not go as far north as Tashkent. They all come from Shikarpur in Scind; they have suffered great loss under the Bolsheviks, as they are typical "speculators." Once when I was waiting in a chemist's shop two Mohammedans came in who talked in Punjabi; but I could not, of course, speak to them or find out who they were. The Hindus and Jews are not allowed to ride a horse or in a carriage in the town, and are obliged to wear a string round their waist outside their cloaks, and may not carry arms. I talked in Russian with some of the Hindus, but could not say who I was or let them know that I could speak their language.

Russians, when in Bokhara, wear the brilliantly coloured *khalat* or robe over their own clothes, and on their heads the small *sart* skull-cap, or in winter a fur cap of the Russian pattern. The Mohammedans wear large white turbans. Nearly every one in Bokhara speaks Persian, and even when talking Turki, I noticed that the traders often used Persian numbers.

Since the disturbances in Russia the traders have been obliged to go to India for their wares, and large caravans arrived frequently from Peshawar through Afghanistan. One enterprising man brought a quantity

of ladies' boots, clothes, and hats, which by now doubtless adorn Komissars' wives. One occasionally saw some old Bokharan brass money, but the chief currency was Russian and Bokharan notes. Only the old Imperial paper money and that issued by the Kerensky government was accepted in the city, but the Turkistan Bolshevik money could be exchanged at about 10 roubles to 1. When purchased in paper roubles everything was very expensive. For instance, a pound of Indian tea cost 180 roubles, or about £18 at the pre-war rate of exchange; cheap cigarettes ("Scissors" was a favourite brand) cost 10 to 12 roubles for a packet of ten. I was obliged to pay 9 roubles each for 5-grain quinine tabloids. I was offered 200 roubles for a 10-rouble note, and 1600 for a 100-franc gold piece, and no doubt, had I really wished to sell and had bargained, I could have obtained more.

At one time during my stay there was very serious trouble between the Turkistan Soviet government and Bokhara. The Turkistan government used to purchase a good many things from Bokhara, mostly goods of European manufacture imported through Afghanistan. As Bokhara refused to accept their local currency, payments were made either by exchange of cotton oil or by payment in Kerensky or Imperial money. Kerensky's government had issued some 250 and 1000 rouble notes properly numbered and controlled, but also some 20 and 40 rouble notes entirely uncontrolled. When Bokhara asked for Kerensky money the Bolsheviks sent this uncontrolled stuff down, and the bazaar was full of people carrying about large rolls consisting of sheets of twenty or thirty of these notes. Twenty-five million roubles of this paper was sent to Bokhara in a few days, when naturally the traders became suspicious of it, though they had been quite prepared to take small quantities as change. The Bolsheviks then accused the Bokharans of breaking their promise to accept Kerensky money.

The Amir of Bokhara lives in a palace, Sittar Mahassar, about 2 or 3 miles outside the town, and nowadays never enters the city. He is always attended by the Kaznachei, or finance minister, who is the minister who has the greatest personal influence with him, while the Khush Begi, who lives in the Ark or fortress in the city, has chief executive power in the State. The Government, although absolutely autocratic, is very much in the hands of the Mohammedan clergy, and as a matter of fact the Amir is very far from having unlimited power. An important officer is the Kazi Kalan, or chief justice, who was frequently seen riding in the streets with his spare horses all gorgeously clothed following behind him, and preceded by a man on horseback carrying an axe as a sign of office. Official couriers also attracted attention by carrying their passport bound in their turban for all to see. Troops could be seen marching through the streets; they gave the impression of extreme inefficiency coupled with complete confidence. The officers wear Russian badges of rank. I once saw a captain playing a fife in the band. The generals are

invariably respectable-looking old men with long white beards, and are preceded by about a dozen mounted men carrying white wands. All ranks are plastered with numerous medals and decorations. The troops always sing as they go; a favourite song is begun, "Amir Baba, the Amir is our father." Another which they used to sing in Russian in Kagan, while the Bolsheviks from the town looked on and laughed, was "Our General is a brave man and does not fear the Bolsheviks."

Bokhara city has always been famed for its fanaticism, and at the gates of the colleges and mosques may always be seen students arguing (in loud tones for the benefit of the passers-by) about knotty points of their religion.

Every one in the city must be in their houses at dusk, and the streets are paraded at night by patrols of police, who carry a drum which they beat as they go along to scare away thieves and robbers. The city is surrounded by a ruined but still strong wall about $7\frac{1}{2}$ miles in circuit. One day when going for a walk on the wall I was arrested by the police on suspicion of being a Bolshevik spy, inspecting the city's defences, but I was released when I met a man in the street who knew me, though of course the police had no idea who I really was. Photographing in the city was forbidden, but from the roof of my house I managed to take a few pictures, and also some on the city wall. The houses of the city are very densely packed together, and there are no open spaces or gardens, except for a patch of reeds near the city wall, in which one day I put up a pheasant. A curious thing about Bokhara is the absence of sparrows. It is the only large city that I know where this bird is never seen, though it is of course common in the surrounding country.

The weather was quite hot in the daytime in October, but at the beginning of November frost began, and we had a fall of snow. Life in Bokhara was pretty dull after the novelty had worn off. We used frequently to go to eat *Shashliks;* these are similar to the Indian *Kabab* —small pieces of mutton on iron skewers, which are cooked while you wait, over a trough containing charcoal which is kept glowing by a hand fan. They are eaten with bread, onion, and a little pepper and salt. Another diversion was the bath. You enter a large upper room, very much open to the sky, where you undress and wrap yourself up in towels and descend to the hot underground room like a Turkish bath. Here, after waiting a few minutes, you are taken to another room less hot, and a man massages and pummels you and cracks all your joints, and finally stands on your back, which he slowly massages with his feet, using his full weight. It is hard not to laugh at what one must look like, but the solemn white-bearded Sarts treated it like a religious ceremony.

One day I visited the prison and gave some money to the prisoners. I had heard a great deal about this prison, but the men I saw seemed as happy as they should be, and were sitting on nice dry clean mats. The damp dungeon where Conolly and Stoddart were kept in 1840 to be

devoured by sheep ticks is, I believe, still in use, but I was not allowed to see it.

During my stay in Bokhara several large parties of Austrian prisoners arrived, who had travelled on foot from Kokhand, taking three months on the journey. The Soviet government would not allow the prisoners to return to their homes, and some of them had not seen their families for more than six years, having been captured by the Russians in their big successes in Galicia in 1914. They were in an absolutely destitute condition, having no money and insufficient clothing, while many were suffering from wounds received in the war and frostbite contracted in Turkistan. Although I could not disclose my identity to them, I visited them and helped those who were sick. It was impossible to assist all, and the Bokharan government refused to do anything for them. They are doubtless still there. One was a Serbian sixty-seven years old, who told me that the Austrians mobilized *all* their Serbian subjects, as they were afraid of disturbances in the districts inhabited by Serbs.

Preparations for departure included the purchase of horses for the long ride across the desert. The purchase of a horse in Central Asia is done with great ceremony. The would-be purchaser rides the horse up and down the bazaar to test the paces; he then dismounts, and the dealer and purchaser sit opposite each other on the ground, while the friends of both parties gather round. They then hold hands under their long sleeves and bargain by making signs with their hands, so that the spectators cannot tell what prices are being named. This system is also followed in Tibet. When a price is agreed on the parties rise, and all their friends congratulate them.

For food we carried Russian *sukhari*. This is ordinary leavened bread dried in the oven. It keeps indefinitely, and though very hard can be eaten when soaked in tea. We also carried salt, tea, sugar, and raisins, and a little fresh meat for the first day or two. Later a Persian showed us how to fry lumps of meat in fat with a good deal of salt, which kept good a surprisingly long time. Each man carried a leather water-bottle hung on the pommel of his saddle, but we carried no water for the animals.

Having purchased our horses and collected our food, we left one night after dark. We had to cross two danger zones. First, the main Transcaspian railway near Kagan, and secondly, the Khushk–Merv line and the Murghab river, which was in Russian territory. There was also the possibility of meeting Red Guards on the Persian frontier.

Although the area of Bokhara State is large, some 85,000 square miles, a good deal of this is desert. The central part near Karshi is the more thickly populated, while the oasis surrounding Bokhara City itself and the banks of the Zarafshan river also contain large numbers of hamlets; but the western districts, except for the banks of the Oxus, are uninhabited desert and steppe.

Our party consisted of about twenty all told, including guides, but we only had seven rifles. We all wore the large Turkoman sheepskin hat, and threw over our clothes a Turkoman cloak, our object being that if seen in the distance we would be taken for a wandering party of Turkomans, though of course a closer inspection would have revealed that we were not what we seemed. Our first night was spent at the edge of the oasis. The next day we started on our monotonous passage of the waterless steppe. We had to cover some 40 miles to the first well, and evening came on with heavy clouds and complete darkness when we were still 4 miles off the well. It was impossible to travel over the desert in the dark, and we soon lost the track, and sat down to await daylight, without water. Very soon, however, rain began, and we all spent a thoroughly miserable night in the open. At daybreak we found that we were actually on the road all the time, and we followed it to the well and watered our thirsty horses. The second day we only covered 26 miles, as we had spent some considerable time drying and feeding at the well. The third day brought us to the town of Burdalik on the Oxus.

Here we remained a couple of days. The people were very good to us and cooked sheep in our honour. The oven was peculiar: a high mud cone in which they burnt brushwood to heat it. This was then taken out and the whole sheep hung in it on green willow withes, and the top covered over. In a short time it was cooked and given to us.

There is a Beg at Burdalik who is Governor of the district. Once a day, in the morning, all the heads of the different branches of the administration have to report to him, being ushered in by officials with white wands. We were told that a similar ceremony is performed daily in the palace at Bokhara when all officers have to report to the Amir. We looked into the lock-up where a few prisoners were sitting on the ground with one leg in a stock which passes down the middle of the room, while their necks are all chained together. Two of the prisoners were to be executed the next day.

The population is Turkoman, who for the most part live a nomadic life in their round felt tents. They are so accustomed to this form of abode that when they adopt a more sedentary life they build reed huts of the same shape and size as their tents. They keep large flocks of the Karakul sheep, from which is obtained the skin we call astrakhan. The ordinary sheep of the country is fat-tailed, but the Karakul has a long thin tail. The price of these lambskins in Bokhara was 100 roubles a piece, though very much larger sums are paid for specially good skins.

On leaving Burdalik we were told that at that time of the year—December—we should find people camped at all the wells, who would sell us grain for our animals and help us to draw water. This would mean that we could travel without camels, which are very slow. The ropes to reach the deepest wells weigh so much that a pony cannot carry them. We were for the first few days disappointed in this, as we found all wells

deserted, and at one time the position appeared serious, as our guides confessed they were lost and we had brought insufficient food for ourselves and our animals.

At one place we had passed a deserted encampment where we found rude shelters made of saxaul branches, with, to our delight, grass wedged in to keep out the wind. This gave our animals an unexpected treat. I had tried to keep a rough reckoning of our route, and calculated that we were about 60 miles from the Murghab river, the only certain place of obtaining water, and I feared that some of our animals would fail to reach this without water. Having lost the track we travelled across the desert, when we came on a path crossing our direction at right angles. One of our Turkoman companions said he could now take us to a well, though he did not know the way to the Murghab river from there. We followed him, and after 26 miles we reached a well where we were fortunate enough to find inhabitants. The water was pulled up in a leather sack by two camels, and I paced the length of the rope and made it 256 yards, and the well must have been over 750 feet deep. The two camels took about 9½ minutes to lift a skin full of water. Had we reached this well to find it unoccupied as had been the case with all the others, we could not have obtained a drop of water as we had no ropes either long or strong enough. Most of the wells we had used were between 60 and 100 feet deep, and these comparatively shallow ones always contained bitter water. This frequently becomes so bad as to be quite undrinkable when the well is abandoned. The deep ones invariably contained beautiful clear fresh water. A flock of three thousand Karakul sheep had just arrived to water, and were driven out the same afternoon; the man took three camels, a donkey and a dog, the camels carrying water to last the whole party about ten days, with the exception of the sheep, who were to get nothing.

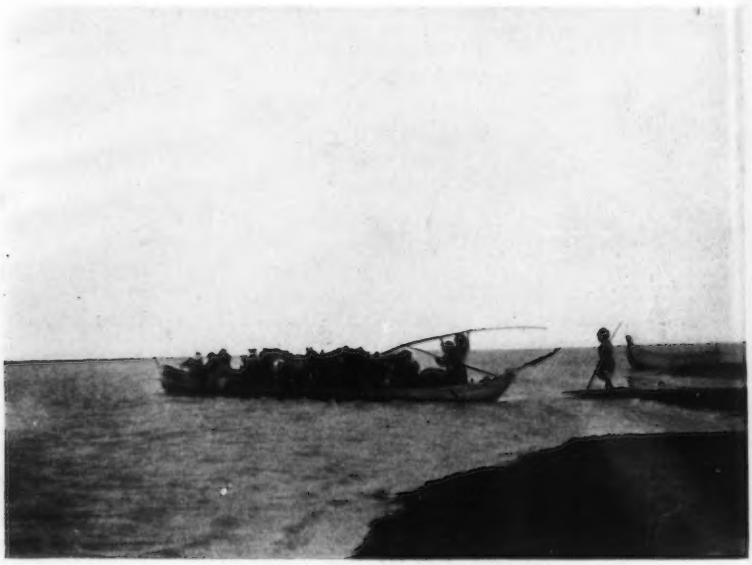
On January 1 we had a blizzard, which deposited about 5 inches of snow, but luckily we had a hut to stop in. Usually we simply lay down on the ground at dusk and got up at daybreak, when it was bitterly cold with a hard frost. This snow was very fortunate for us, as it made us independent of wells and we were always sure of fresh water instead of the usual ration of brine, though it was unpleasant to sleep in the snow at night. About this time of year snowstorms sweep over the desert, but the hot sun soon melts the snow, and as if by magic small shoots of grass appear. It is for this grazing that the Turkomans bring out their enormous flocks of sheep. Later in the year when this grass is dried up the desert is absolutely deserted. The flocks are taken away from the well for about twenty days if there has been rain or snow, which will give the sheep an occasional drink. If the desert is quite dry they are obliged to return for water after eight or ten days.

The desert through which we travelled was covered with small bushes called *saxaul*, which thrives with very little water. It burns very well, and

PARTY OF TURKOMANS IN THE DESERT NEAR THE RIVER MURGHAB

THE HORSE MARKET, BOKHARA

WELL IN THE DESERT EAST OF THE OXUS



CROSSING THE OXUS AT BURDALIK

was the chief fuel supply for the railways of Turkistan when they were cut off from the Baku oil. The appearance of the desert was that of a stormy sea frozen solid, the waves or hillocks being 10 to 20 feet high in most places, and the distant horizon appearing absolutely flat.

Animal-life there was none at this time of year, but further to the west in the neighbourhood of the Murghab river there were numbers of gazelle and a few larks and many rats or marmots, while the shells of tortoises everywhere testified to their presence, though at the time of our journey they were hibernating. We also saw a few sand-grouse, and on the Oxus river were geese and ducks and pheasants in the bushes on the banks. At Burdalik we met a hawker who had just killed two pheasants.

The desert is infested with bands of Turkoman robbers, but our party was large enough to be safe from attack, though had it been known that we were mostly unarmed we should probably not have been unmolested.

All travellers agree that the Turkoman is the most persistent robber. He rides about his desert from well to well on his wonderful pony and attacks and plunders all he meets. The ponies are really marvellous. They have several well-recognized breeds, but the quality which they require and which all possess is that of being able to carry a light weight for very long distances without food or water at about 5 or 6 miles an hour; in other words, they would be ideal for mounted infantry work, provided that the soldier does not insist on too many comforts and can travel light. In Bokhara they told me of a Turkoman who had just killed a Bokharan official at Karakul and had fled to the desert. I said it would be easy enough to catch him, as they had only to watch all the known wells and they must get him soon. They said that this did not follow, as he had trained his pony to live on mutton fat, and if this is done a pony can go two months or longer without water. Although one cannot believe all one hears, we had experience of their wonderful endurance. After watering, Turkoman horses are always galloped for two or three minutes even after the longest and most tiring march. If this is not done they say they get ill and frequently die. I bought eight ponies in Bokhara for 35,000 roubles which carried us through to Meshed, a distance of close on 600 miles.

The whole nomad Turkoman population lives in constant fear of robbers of their own race. This was exemplified on several occasions. We were a party of about twenty-five, and on approaching one well we noticed a man riding hard a mile or two on our left. He was soon hidden by a fold in the ground, and presently we came in sight of the well a mile off. A single man rode out to meet us, and we sent one man on to speak with him. It turned out that the man we had seen thought we were a party of robbers and rode in to warn the people at the well. They, on receiving the news, loaded their rifles and lined the walls of the enclosure and prepared to resist, but sent one of their number forward to make sure before any blood was shed. We sent their envoy back, and presently he

signalled that it was all right and we rode up. We then discovered that the people at the well were themselves noted robbers, but the size of our party frightened them. We, however, divided the night up into watches, and took it in turn to have three of our number watching all night. These people had some fine Persian greyhounds which they use for catching gazelles. They told us that they can only catch gazelles when they are thin, as when fat they cannot get a grip with their teeth.

On another occasion, after crossing the Murghab river, when we were very short of food we came to a well at dusk and found one Turkoman drawing water. We asked where his camp was, and after some prevarication he said it was about 2 miles off. We were very short of food, so made him lead us to them in the hope that they would sell us something. When we got in sight of the camp fires he made our party halt while I and an interpreter accompanied him. When about 50 yards off he asked us to stop while he went forward to explain. The Turkoman then shouted that we must move further off as they were afraid, and they would then send a man to us with food. They then called out that they would give us nothing, and that they had loaded their rifles and would fire if we did not go off at once. We were obliged to comply, and the next day we met a man who said that they were a party of robbers, who, thinking we were another party who would attack them, had moved off that night as soon as we had left.

Later we came on a camp of Turkoman shepherds. We had had practically nothing to eat for several days except the ponies' food, which we either parched or boiled according to the individual taste. They were terrified at seeing such a large party, and thought that the worst had happened. However, they soon saw that we meant no harm. These men sold us three sheep, which we ate on the spot, cooking *shashliks* on the cleaning rods of our rifles. They also made us some good fresh bread by laying the unleavened cake on the hot earth after scraping away the fire and covering it with glowing ashes. This was cooked in about twenty minutes. We asked these people to sell us some flour, but they excused themselves, saying that they had only enough left for their own use, but that at a well some 9 versts on we should find all we wanted. We left them, and on approaching the well we found to our dismay that it was quite deserted. We found out that the people at the well had seen our large party ride up to the men who were out grazing their flocks, and, thinking we were a gang of robbers, they had decamped to a man, and intended to live some distance off in the desert and not return to the well until we had moved off. The above incidents will show the continuous dread of robbers in which the Turkoman lives.

We crossed the Murghab river at night. We were in danger of being intercepted by Bolsheviks here, as they patrol the Khushk–Merv railway line which runs near the river. We found the river about 20 yards wide, with steep banks, and our ponies were forced to swim. We were now well out of Bokhara territory.

The western Bokharan frontier is an undefined line in the desert some 5 or 10 miles to the west of the Oxus, but Bokharan subjects graze all over the desert between the Oxus and Murghab rivers, and the control of the Russians over their subjects in the Murghab valley is very loose.

From the Murghab river we had several days more of desert travelling to the Persian frontier, where we had a brush with a Bolshevik patrol, and it was with a feeling of overwhelmlng relief that we trod on the soil of Persia and were free from the tyranny inseparable from Soviet rule.

The PRESIDENT: We have listened to a long list of Fellows who have been elected, but there was to have been one elected whom I am sorry to say, since he was proposed at our Council meeting a fortnight ago, we have heard has died during a journey on the China-Burmese frontier. I allude to Mr. Reginald Farrer, and we do greatly deplore the loss of this traveller, because he was a man of exceptional refinement and culture, who minutely observed and very carefully recorded and described the natural features of the countries through which he was passing. He also had a peculiar knack of getting on with all kinds and conditions of people, including Government officials, and overcoming those human obstacles which are often the most serious obstacles with which a traveller is confronted. Only a fortnight ago I had a letter from Mr. Reginald Farrer dated from the borders of Burma and China in which he described his present two years' journey upon that frontier, and outlined another travel on which he had set his heart, and in which he had asked my help so far as I could give it, and that was to go to Lhasa in Tibet. We very much regret his loss, because I looked upon him as the forerunner of a new type of traveller, who, taking advantage of the pioneering of his predecessors, would have brought back to us those cultured descriptions of the beauties of Nature and of plant, animal, and human life in the countries through which he was travelling, which I consider are the very flower of geographical knowledge.

Our lecturer this evening is Major Bailey, whom we all know, and we are specially beholden to him, because for many years past he has been suffering ome very severe hardships and strain. He was wounded in the battle of Ypres and in both legs in the Gallipoli campaign. He served afterwards in Baghdad, and from there he went to Central Asia, and was in hiding and eventually escaped from the clutches of the Soviet rule in Turkistan. He is, therefore, well entitled to a good holiday, but he has come here this evening to give an account of his experiences in Bokhara, and we are glad to welcome him.

Major Bailey then read the paper printed above, and a discussion followed.

The PRESIDENT: Sir Michael O'Dwyer, the distinguished Governor of the Punjab, is present. To him is due as much as to any living man that the Provisional Government of India of which we have heard never came into actual being. He has been to Bokhara, and knows something also of this great Indian Prince who was to rule in India, and perhaps he will very kindly give us some remarks about the lecture.

Sir MICHAEL O'DWYER: To-night I have had the honour of being the guest of the Geographical Club, and in that moment of enthusiasm which follows a good dinner I rashly promised the President to say a few words on the subject of the lecture. The President's request was based on the fact that I was once in Bokhara; that is many years ago—as far back as 1896, and one's memory of

those times is getting blurred. But the admirable lecture which we have just listened to, and the excellent slides we have seen, recall a few associations of the days when I was in Bokhara. The memory which stands out more vividly than any other is this. I remember on a summer's evening early in May 1896 being on the railway station at Kagan, close to Bokhara, where there was a brilliant crowd assembled. The Emir of Bokhara was departing in a special train with a splendid retinue to attend the coronation of the Tsar of all the Russias at Moscow. A few months afterwards, being in Moscow, I had the opportunity of seeing again, not only the Emir, but the Tsar at the Coronation ceremonial, and now the two are associated in our minds with the same tragic fate which both have met at the hands of the Bolshevists. The Tsar has lost his Empire, life, and all near and dear to him, and the latest news of the Emir of Bokhara is that he is a fugitive from his capital, that his kingdom is in the hands of the Bolshevists, and the great city of Bokhara, which was the centre of Islamic civilization and culture and the great trade emporium of Central Asia, has now become a prey to rapine and bloodshed. One regrets the downfall of a great city like Bokhara. One hopes it may shake off the blight of Bolshevism and recover its pristine glory, which has won for it the title of Bokhara the Noble (Sharif). Most of us here in England may say it is a long way off and does not particularly interest us; but apart from the political significance of the events which have made the Bolshevists dominant in Bokhara, events which cannot but react on Persia, Afghanistan, and India, this downfall of the Emir and the native Government has also very considerable economic importance. Bokhara is the great mart of Central Asia, and was a great outlet for British and Indian trade. The few days I spent in its bazâar I was astonished at their great wealth—to my mind, far superior to anything in India. The products of Persia, Afghanistan, of Northern India, of Western China, of Europe were all collected there and were being freely exchanged under conditions of order and security; for the Bokharan Government, to its credit be it said, during all the centuries during which it maintained its independence, was conspicuous for two great things. In the first place, it always protected trade and travellers, and, in the second place, it maintained a reliable gold currency which had never been debased, and which was accepted with confidence in every market from Nijni Novgorod to Kabul and Kashgar, if not Further China. When you note these two facts, the great protection given to travellers which attracted traders from every quarter of Central Asia, from India, Turkey, and Russia to Bokhara, and the stability of the coinage, you have the explanation of the wonderful success of Bokhara as a commercial capital. Major Bailey has told us of the great number of Jews and Hindus there. When I was in Bokhara I went to see the Indian bazaar. I found a large colony of Indians, quite happy and prosperous, and they were very glad to meet one who could speak their language. Directly I appeared they produced the Anglo-Indian national drink—whisky and soda! I believe at that time it was the only place in Central Asia east of Baku, if not of Tiflis, where you could get a whisky and soda; but my Indian friends at once produced it and the Russian cigarettes. It was interesting to note where they came from. There were a good many Peshawar Mohammedans amongst them, but the great majority were Hindus from Shikarpur in Sind, and there were a certain number of Sikhs and other Punjabis. I got into conversation with one fine Sikh and asked him how long he had been there. He was a little reticent about answering, but in the end I succeeded in getting from him that he came from a village near Amritsar and had been twenty-two years in Bokhara. I said, "Have you

no desire to go back?" All the others return every four or five years. He shook his head, and finally said, "Tell me, is Warburton Sahib still there?" Mr. Warburton was a famous Punjab police officer whom you find immortalized in 'Kim' and others of Kipling's books. I met Mr. Warburton some years later in India and explained how his name and fame resounded in distant Bokhara, and it turned out this Sikh was one of the men who organized in 1873 the murder of the Mohammedan butchers because they killed the sacred cow. Mr. Warburton got to the bottom of the conspiracy, and some were hanged, but this man got away and never dared to return.

Major Bailey has explained very clearly how Bokhara is dominated from Russian territory. It lies between the Transcaspian province on the west and the Turkistan province on the east. One means by which Bokhara is throttled lies in the railway which runs through those provinces and Bokhara being entirely controlled by Russians, and the other (and, so far as I could ascertain, the more effective method) of strangling Bokhara is the possession by Russian Turkistan of the headwaters of the Zarafshàn, which means "The Gold Scatterer"—that is, the waters of this river are so fertilizing that they produce the magic effect of gold. It brings down from Russian territory enough water for the irrigation on which Turkistan and Bokhara depend, but the Russian authorities control the upper waters and the supply below, and they sometimes say, "We want all this water for our own territory." Bokhara is particularly dependent upon the waters of this river, because so far as I could see the soil was in places steadily deteriorating. Wherever you watered from wells the water was brackish. The result was that the ground was covered with salt, and the only way of working off this was by copious inundations of river water. As I have hinted, Bokhara was the meeting-place not only of men engaged in honourable business, trade, and commerce, but also the refuge of some rather shady customers, criminals and political conspirators, and Major Bailey has told you of one of these who, though passing as an Indian prince, was plotting against the British Government. I saw something of the other side of the movement in the Punjab, and I do know that the information which Major Bailey brought back as the result of his thrilling adventures has been of enormous value politically as throwing much light, not only on the doings of the Bolshevists, but on the intrigues of all the various anti-British factions which are gathered under the wings of Bolshevist Russia in Bokhara and elsewhere. This man Mahendra Partab was perhaps the most important of those plotters. He is a man who owned very large landed estates—now sequestrated—in the United Provinces. He is married to the sister of one of the ruling princes of the Punjab. In his early days he developed a dreamy idealism which characterizes a certain number of the Indian revolutionaries. He read everything Tolstoy wrote and adopted those notions of Tolstoy's which to my mind have prepared the way for Bolshevism in Russia and indirectly for a similar movement in India. When he left India his sole idea was to bring about the downfall of the British Government, and prepare the way for the restoration of the mythical golden age of Hinduism. To do this he got into touch with the Germans at Berlin. He was introduced to the Emperor, I believe, as a representative of the Indian princes, and made a member of the Council in Berlin which during the war dealt with Eastern affairs. It was through him, and another man of the same kind, an Indian Mohammedan named Barkatullah, that the Germans endeavoured to foment rebellion in India. There were several other seditious Indians helping the Germans, but these two men had a certain amount of influence in India, and they deluded the Germans in Berlin into believing they could bring about

a rising there. You will be glad to hear, as showing the spirit of loyalty among the Indian princes, that whenever Mahendra Partab sent letters to his wife, who is the sister of an Indian prince, this prince at once took possession of these letters, and without opening them sent them on to Government. He also insisted that his sister and her family should leave the estates of and sever all connection with this disloyal rebel, and soon after that I think his property was confiscated. One other sidelight on Bolshevist methods came to my notice before I left the Punjab. The Bolshevists having established themselves at Bokhara sent their agents down to Kabul. A notorious Bolshevist leader appeared there named Bravin. It was interesting to see how clever they were in selecting the right man for the work. Bravin had been attached to the Russian Consulate in Calcutta for many years and made himself very well known there, and when the Bolshevist movement spread he was one of the first selected for special service in the direction of India. When the Afghans invaded India last year on the invitation of the Indian sedition-mongers and threatened all our North-West Frontier, their Generalissimo, Nadir Khan, had a big force at Thal in our territory which was smashed up by General Dyer. The Generalissimo fled in hot haste and left a lot of his papers behind him, including a very detailed plan prepared by Mahendra Partab and Barkatullah for the provisional government of India. As far as I remember, it got over the sectarian difficulty mentioned by Major Bailey of Mohammedan domination by sharing the position of the President of the Indian Republic between one Hindu and one Mohammedan! I do not know that there is anything else except I am sure we all hope that the old historic capital of Central Asia, which has filled so large a part, not only in the political but the commercial world, may be raised again to its pristine greatness. Bokhara has always had a keen demand for the best kinds of English goods. When I was in Bokhara the Russians had brought the Bokharan state within their trade system and imposed very heavy taxation against all goods of non-Russian origin. The Bokharan is as particular about his clothes, especially his head-dress, and cultivates the latest fashions in headgear, as an English or Parisian lady. The Russians had hoped to exclude English goods by putting on a very heavy tariff, but the Manchester muslin was of so fine a quality that no Russian loom could approach it, and the Bokharans at that time were paying fabulous prices for Manchester muslin smuggled in through Afghanistan, because they found it much finer than anything they could get from Russian sources. Bokhara under Bolshevist rule is, I believe, now entirely cut off from British and British Indian trade, and the Indian press reports that the city has been completely looted, and the merchants have all fled. Let us hope that this is only a temporary eclipse.

The PRESIDENT: Sir Aurel Stein, who made those wonderful journeys in Central Asia and more particularly Chinese Turkistan, is here, and we should be very glad if he would give us a few words.

Sir AUREL STEIN: It is a great honour to be called upon to offer any remarks after this fascinating lecture which we have heard from Major Bailey, telling us of wonderful adventures such as one expects to read of only in distant history, and after the most striking observations which my old chief and friend Sir Michael O'Dwyer has just given us on what is a very recent past in India and Bokhara. It is true I have been in Bokhara territory. But though it is only five years ago that I travelled through the whole length of the mountainous part of its territory, I feel as if it were old history. Four years ago there was still the Imperial power of Russia smoothing the way for

me in the service of the Indian Government, making things in Bokhara as easy for me as in any Indian native state; and now we have had to learn of the wholly different conditions under which Major Bailey had to do his work.

I was travelling there in 1915 for scientific purposes. I wanted to see as much as I could of a very important ancient passage land which had once seen most of the intercourse between the classical West and the Far East. Sir Michael O'Dwyer has been rightly putting special stress upon the important fact that Bokhara from the earliest times has been one of the great commercial centres of Asia. This must impress any experienced observer of modern conditions in Bokhara itself. If reference to ancient history were needed, I have only to mention that Sogdiana (which was the old name of the territory which you have so often seen here on the map between the Oxus in the south and the Sir-darya or Yaxartes in the north) was a chief place of interchange between three great civilizations. I mean the Hellenistic civilization of the Near East which had penetrated through Persia; then the civilization of India which had spread northward with Buddhism; and thirdly, the culture, trade, and organized power of China, which for more than one century before and one century after the time of Christ, and again in the seventh and eighth centuries of our era, had maintained a dominating influence over great portions of Central Asia.

I shall not attempt now to give you indications of the many interesting facts we know about the part which Bokhara had played in the history of innermost Asia. I shall mention only one fact which will be of interest to you as students of geography: it illustrates how physical conditions determine the character of the population far more than race or language. We have heard here interesting accounts, and have seen too on the screen glimpses, of the present Turkomans, who have now happily resumed that rôle of nomadic robbers which the beneficent repression of the quondam Russian government had denied to them for a short period. In that very territory, long before the Turks had appeared on the stage of Central Asia, there had lived a people wholly distinct in language and race, but doing exactly the same things. They were those tribes of Iranian speech but nomadic habits whom the peaceful settled population of Persia knew and dreaded as "Turanians." Considering their ancient reputation it was quite amusing to me in Bokhara City to have to put up in a kind of hotel which called itself the "Turanski Numer." It was evidence how the term *Turan* had been brought to life again by the sort of Pan-Islamic propaganda that went on long before the war.

The historic rôle of Bokhara, I am sure, has not changed in essentials since those days when it witnessed the interchange of Persian, Chinese, and Indian civilizations, and I believe, whatever misfortunes that great city has recently undergone, geographical facts will re-establish its importance within a not very distant period. But I also believe that no change in the controlling power will ever dispose of the facilities which the desert, of which you have seen so many photographs, offers to people on its borders. The same Turkomans who now have taken again to the part of robbers had since the Russian occupation of Transcaspia in the seventies of the last century been obliged to content themselves with making plentiful money by cotton cultivation and the production of wool. Yet that period of some forty years of peaceful prosperity has not killed the ancient fascination of another and more congenial life which such ground must foster.

I wonder whether the present conditions will continue long enough for us to see demonstrated afresh the wonderful performances of the Turkoman

pony. When I was passing down the Perso-Afghan border in 1915—under conditions which, I may note in passing, were not quite those of peace—I had the good fortune to fall in with three Turkomans of the old type, then in the service of the British Consulate-General at Meshed. These men were employed to look after the Indian mail-bags passing through Afghan territory. They told me interesting details as to how those raids which once brought bands of Turkoman raiders right down to Seistan, some 400 miles off, were planned; how the ponies used for them had been trained, etc. I regretted then not to have had enough time for collecting more information on the subject. If conditions continue as at present, it may soon be possible to hear similar stories of modern raids.

There is one more matter with regard to which ancient history can be studied afresh on the same ground. Bokhara is a typical "terminal oasis," to use the proper geographical term, and such oases which derive their irrigation from the terminal course of a river are particularly dependent for their prosperity upon the maintenance of a firm government, not only in their own areas but also higher up. Whenever political troubles or similar disturbances lead to the neglect of, or interference with, the irrigation system at the canal head a terminal oasis is bound to undergo a great crisis, which, on such ground as Chinese Turkistan offers, may eventually result in complete extinction.

I have often been asked for my views as to how those ancient oases of the Tarim basin, now buried in drift-sand, which I had the good fortune to explore, had originally come to be abandoned. In reply I have always emphasized the limitation of the available archæological evidence. This could indeed prove within which period those oases were abandoned, what kind of civilization once flourished there, etc. But archæological indications in the absence of historical records do not suffice to show what was the direct cause which first started abandonment.

The human factor is a very complex one and liable to be affected by changes correspondingly varied in character. Among the possible causes leading to the abandonment of oases the theory which attributes it to "desiccation" also deserves careful consideration. It has found much favour since Prof. Huntington's very stimulating publications have made geographers and others familiar with the idea of pulsatory changes of climate leading to far-reaching historical effects.

It may be safely assumed that since those oases in Chinese Turkistan were abandoned to the desert the climate has become more arid, or anyhow the amount of water available for irrigation much reduced. But this does not prove that it was "desiccation" itself which caused abandonment in the first instance. A *post hoc* does not necessarily mean a *propter hoc*. I am unable to accept that assumption as a "working theory," because I realize the peculiar complexity of the human factor, and also because it is impossible to test such a "working theory" by experiment. This may be unfortunate; but in this respect geography, like history, differs from exact sciences.

If then we cannot have experiments, it must be of additional interest to observe that our own time supplies evidence that the area of Central-Asian oases like Bokhara can be affected very closely by political changes. From reliable information I received, it appears that the maladministration attending the present Soviet *régime* in Russian Turkistan and the consequent neglect of the canal system has led in Farghana to the abandonment of much land in the lower portion of the hitherto rich and closely cultivated tracts. Now, I suppose if I came back myself to that ground after two thousand years and found there

archæologically datable remains of settlements abandoned at the present period it would be so easy to come to the conclusion that this abandonment must have been due to climatic change bringing about increased aridity. Suppose that no records of the present period survive two thousand years hence, and it will be impossible then to prove that this conclusion was wrong and that the abandonment had been the direct result of a great political upheaval. Whether any scientist is prepared to explain the present period of upheaval on this globe of ours as due to increased aridity, I do not know. Anyhow, here is a case where the history of our own time aptly illustrates the difficulty facing the critical student when he is expected to judge of the causes of past events in the absence of actual records.

I wish only to add that all Major Bailey has told you and shown on the screen is indeed most instructive, not only to the geographer and the student of Eastern humanity, but to the historian as well. In geography we cannot make experiments; but here contemporary developments strikingly show us how historical changes affect all the aspects of human life with which geography is dealing.

The PRESIDENT: Colonel Yate was engaged thirty-five years ago in delimiting the boundary between Afghanistan and Russia in that part over which Major Bailey escaped.

Colonel C. E. YATE: I have never been in Bokhara myself, but I well remember coming to the frontiers of Bokhara and being received by a Bokharan Court of Honour, and I must confess I can endorse what Major Bailey has said when he described the Bokharan soldiers as giving the impression of extreme inefficiency. I never saw such an extraordinary collection of men in their yellow leather trousers over long top boots and most extraordinary arms and weapons; the music and band and whole turn-out were a sight I shall never forget. I know the part of the country south of Bokhara stretching from the Oxus to the Persian frontier, where I spent several years in the delimitation of the Russian and the Afghan frontier. After some two years in the country with the Afghan Boundary Commission under General Sir Peter Lumsden, I was finally sent out to build up all the boundary pillars in that whole tract of country. I followed Major Bailey's journey across the desert with the greatest interest. I remember when, after travelling through the desert, we came to the end of our journey on the banks of the Oxus, the Russian officers and ourselves embarked on a boat and floated down that river till we got to the railway, and then went on to Merv, and so home. We had a wonderful time travelling down the Oxus, and we never stopped day or night. I remember we had certain food in tins with us to eat, but the Russians had nothing to eat but a sturgeon, and that we found so good that we all fed for days on it and never touched the other things. When Major Bailey described his crossing of the Oxus I was wondering how he would get across. We saw the picture of the boat he crossed in, and apparently, I understand, they rowed the boat across. At Kilif I remember seeing a similar ferry-boat to the one shown, but that boat was drawn by a couple of horses. They were harnessed to the boat and went into the water, and a man stood in the bows with a whip, and those horses swam across. It was a curious instance of what horses can do. I never dreamt till I saw it that a couple of small horses could take a big, heavy boat across such a deep and swift river nearly half a mile in breadth. I had to demarcate the boundary from Meshed to the Oxus, and had to construct all the pillars as marked on this map. Every one who has travelled in these regions has vivid recollections of the bitter water and salt wells referred to by Major

Bailey. I had to live for a fortnight once on a well of Epsom salts, and I well remember it! Another thing that I sympathized with Major Bailey in was the snowstorm he told us of. I remember starting one April day with thirty camels laden with water out into a waterless tract of desert. That night a most awful blizzard came on, and by the morning there were a couple of feet of snow. The muleteers had left the corn for the mules behind because the young spring grass was up, and the animals would look at nothing else. The snow came down in this awful blizzard, and though the horses and mules tried to get down through the snow to the grass, they could not do it, and were very near starving. There it was that I came to realize what a splendid guide a Turkoman is. He seemed to know every well and road in the country, and carefully guided us through the storm to a place where we could find wood, light a fire, and get some food both for man and beast. I have ridden hundreds, I may say thousands, of miles with these Turkomans, and they never once failed to guide me right. Sir Aurel Stein has told us of the Turkomans who were on the mail line between Meshed and Herat. They were there with me when I was Consul-General at Meshed. All those Turkomans refused to go back to service in Russia when Panjdeh was taken by Russia in 1885, and asked to become British subjects. These men, I believe, are still in the British service, and employed on the same postal duty between Meshed and Herat, and I can only say they have always been most extraordinarily faithful followers of the British Government. They were robbers, it is true, and I suppose when the opportunity occurs they always will be robbers. They used to raid the whole of the Persian frontier in olden days, carry off slaves, and keep them. Whether this will break out again, as has been suggested, I cannot say, but we on the Afghan Boundary Commission found them capital fellows, and I certainly have the most pleasant recollections of them all. While on this frontier we found a most beautiful species of pheasant. When Colonel Peacock of the Engineers and myself were demarcating the boundary, we used to go out with the Turkomans and ride these pheasants down, as after two or three flights they used to hide in the snow, and their tails betrayed them. We brought home half a dozen, and they were declared to be a new species and named *Phasianus Principii*, or Prince of Wales' Pheasant; but it was found that they would not breed in captivity. They were magnificent birds. I was at Panjdeh at the time when the Russians drove out the Afghans. Within the last few days we have heard that the Afghans have now some troops in Merv, but what is going to happen there we none of us can say. Although the Afghans are in Merv, we hear that the Bolshevists are in Kushk, to the south of it, and consequently I do not think that Merv can be now the frontier of Afghanistan, as I have heard said, because whatever Government is in power in Russia, their hold on Central Asia depends on that one line of the Transcaspian railway, and I cannot think any Government in Russia will allow the Afghans to cut that line. I was at a lecture the other day by a very well-educated young Afghan. He dwelt on the advantages of a Mohammedan federation in Central Asia between Afghanistan, Persia, and Bokhara. Now what has become of the Emir of Bokhara none of us know; he has been driven out by the Bolshevists, and is in flight. There is no love lost between the Usbegs of Bokhara and the Afghans as a rule, but whether they will join up now under the terrible threat of the Bolshevists is a question that has still to be settled. There is also no love lost between the Afghans and the Persians. The Afghans overran Persia years ago—they may do it again. We hear a great deal now about the defence of Persia from the Bolshevists, and the few troops we have in North-West Persia

What will happen there none of us can say. Whether the Persians will accept our agreement or not none of us know. I cannot help thinking that if we do come to a Mohammedan federation in Central Asia it would conduce to stability in those regions, but none of us can say what will happen there. We can only hope that the Afghans will see wisdom, and that they will turn to the British instead of to the Bolshevists, and that we shall not have any fresh trouble with them as we had last year, when they so outrageously and wantonly attempted to invade India.

The PRESIDENT : I am sure we should wish to congratulate Major Bailey upon his wonderful escapes and the great resource which he showed in dealing with critical situations. He is the most remarkable man I know of for getting himself into nasty situations and getting himself out of them again.

MODERN DEEP-SEA RESEARCH IN THE EAST INDIAN ARCHIPELAGO

Prof. G. A. F. Molengraaff, of Delft

Read at the Meeting of the Society, 7 June 1920. *Map following p.* 152.

SUBMARINE topography all over the world is much simpler than the topography of the subaerial portion of the globe. This is, at least near the continental borders, evidently the consequence of the covering or blanketing influence of continuous sedimentation on the relief of the sea-bottoms contrasting with the carving and sculpturing influence of never-ceasing erosion on the land surfaces. Wherever this rule does not hold good the submarine topography, not yet being obliterated by sedimentation, must be of recent date. A bold relief of the sea-bottom is therefore, at least near the continents, apt to indicate portions of the Earth's crust which either have been warped in recent geological time or still continue to be orogenetically active, and thus continually rejuvenate and remould the sculpture of their surface. In this paper the latter alternative will be discussed for the Australasian seas.

One of the major results of deep-sea research, a branch of science of modern date, has been the statement of the fact that the so-called mediterranean seas are, as compared with the grand oceans, characterized by a bold and diversely developed submarine topography.

Mediterranean seas are, as the name indicates, seas which separate continents one from the other; in a somewhat narrower sense the name is given to those mediterranean seas which separate the great continents of the northern hemisphere from the southern continents, viz. the Caribbean Mediterranean between North and South America, the Mediterranean Sea in the strict sense between Europe and Africa, and the Australasian Mediterranean sea between Asia and Australia.

One of the peculiarities of the topography of the mediterranean seas proved to be the existence of basins, often of great extent, separated from

the great oceans by submarine barriers or ridges of varying depths. To these basins, notwithstanding their great depths, the cold water from the abysmal portion of the oceans cannot have access. Consequently in each of those basins the temperature of the water below the deepest point of the ridge or barrier separating it from the ocean remains constant, whatever figure its entire depth may attain.

The submarine topography of the European Mediterranean Sea is known by various investigations dating from the year 1879, and our knowledge of the Caribbean Mediterranean Sea is chiefly based upon the results obtained by the *Blake* in the years 1877–1880. In the Australasian Mediterranean Sea the first deep soundings have been made with an inadequate equipment by Siedenburg in the year 1858. A small but important series of deep soundings carried out by the famous *Challenger* Expedition in the years 1874 and 1875 made known the great depths of some of the basins of the East Indian archipelago; and later a few data were added to the list by the soundings of the German vessels *Gazelle* in the year 1875 and *Valdivia* in the year 1899, as well as by those of the British vessels *Egeria* and *Rambler* in the years 1888 and 1890.

Only in the years 1899 and 1900 a well-equipped expedition, the *Siboga* Expedition, directed by Prof. M. Weber, succeeded in revealing many of the secrets hidden by the East Indian waters. By 238 soundings, made at the same number of stations, so many data were obtained about the submarine topography, that upon these and some other records mentioned above, the present Vice-Admiral G. F. Tydeman (Bibl. 22), then the naval chief of the *Siboga* Expedition, found it possible to publish in the year 1903 the first chart of the depths of the sea in the East Indian archipelago.

Additional data were obtained by later deep-sea work carried out by the Dutch vessels *Bali*, *Edi*, *and Telegraaf* in the years 1903, 1905 and 1910, the German vessel *Planet* in the year 1906, and others. Every new fact added to our knowledge of the submarine topography of the East Indian archipelago has given fresh evidence of its diversity, and proves its features to be bolder and more complicated the more they are known. At present no less than thirty larger and smaller deep-sea basins are known to exist in the East Indian archipelago. They are enumerated in the list given on p. 97, with the exception of some minor depressions of small extent. In this list are also incorporated the Andaman basin and the South China basin, although they only touch the borders of the archipelago, and do not belong to it.

To the deeper portions of the Andaman basin, the Mentawei basin, the Java trough and the Timor basin, only the water of the Indian Ocean has access, whereas the deeper water of all the other basins is connected only with the Pacific Ocean. The extensive basin of the Banda sea, and with it the Wetter trough, the Savu basin, the Flores basin, the Saleyer trough, and the Buton trough, is separated from both oceans by a rim,

BASINS OF THE EAST INDIAN ARCHIPELAGO.

	Greatest depth in metres.	*Authorities.*	*Lowest point of the rim separating the basin from the oceans.*	*Temperature of homotherm water-mass in degrees Centigrade.*
Andaman basin	4177	Investigator?	1200	5·2
Mentawei basin	1671	Valdivia	900	5·9
Mentawei trough or Sunda trough	5214	Valdivia	—	—
Java trough	7100	Planet	5800	—
Timor Sea	3109	—	±2000	3·0
Kei trough	3565	Siboga	±1600	—
Ceram–Aru trough	2571	Rambler	±1600	—
Flores Sea	5121	Egeria	1650	3·3
Savu Sea	3758	Gazelle	1650	3·3
Wetter trough	3257	—	1650	3·3
Saleyer trough	3110	Siboga	1650	3·3
Buton trough	3335	Bali	1650	3·3
Kalao trough	2124	—	—	—
North-western Banda Sea ...	5098	Bali	1650	3·3
Central Banda Sea	5121	Challenger	1650	3·3
Eastern Banda Sea, including the Weber deep	6505	Penguin	1650	3·3
Batyan trough	4709	—	±2000	—
Gorontalo trough	3755	Bali	±1880	3·1
Sangir trough	3302	Siboga	±1880	—
Togean basin	1800	Bali	—	—
Tomini basin	2006	,,	—	—
Celebes Sea, including the strait of Makassar	5111	Rambler	1400	3·7
Sulu basin	4663	Challenger	380	10·2
Halmaheira basin	2039	Siboga	±1100	—
Mindanao trough, central portion	8500	Planet	—	—
Mindanao trough, southern portion	7243	Edi	—	—
China Sea, central portion ...	4965	Egeria	—	2·8
Palawan trough	2877	—	—	—

the lowest point of which is situated at a depth of 1600 metres between the Sulu islands and Obi Major. Over this rim the water of the Pacific Ocean communicates through the Molucca passage with the deeper water of the Banda basin. The homothermic water below 1650 metres in the Banda sea, and all the basins connected with it have a uniform temperature of 3·3° C. The Sulu basin is more enclosed than any of the others, and below 380 metres its water has no communication at all with the oceans. From that depth to the bottom at 4663 metres its water has a temperature of 10·2° C. throughout.

The deposits formed in those more or less enclosed basins have been examined by Böggild (Bibl. 2). As none of them are formed very far from land, terrigenous deposits much preponderate, and pure oceanic deposits free from terrigenous elements are absent. Nevertheless Böggild adopts the classification introduced by Murray and Renard for the oceanic deposits collected by the *Challenger* Expedition, remarking, however, that all the oozes found in those basins are more or less modified by an

admixture of terrigenous material. Thus, for instance, both blue mud and volcanic mud are called Globigerina ooze by Böggild as soon as they contain more than fifty per cent. of carbonate of lime in the form of shells of Globigerina.

The most remarkable outcome of the researches of Böggild is, that in the basins of the East Indian archipelago the percentage of carbonate of lime in the bottom deposits diminishes with increasing depths at a rate more rapid than in the oceans. The decrease in the percentage of the carbonate of lime in the deposits of those basins towards the depths is shown in the following table:

Depth in metres.	*Number of samples.*	*Average percentage of carbonate of lime.*
0–500	26	43·2
500–1000	16	38·0
1000–1500	12	31·2
1500–2000	10	32·2
2000–2500	11	24·0
2500–3000	9	25·7
3000–3500	4	23·6
3500–4000	4	8·4
>4000	14	2·1

In the open oceans Murray and Renard (Bibl. 15, p. 279) have found the relations between the depth of the sea and the percentage of carbonate of lime in the deposits to be as follows:

Depth in metres.	*Number of samples.*	*Average percentage of carbonate of lime.*
1–900	14	86·04
900–1800	7	66·86
1800–2700	24	70·87
2700–3600	42	69·55
3600–4500	68	46·73
4500–5400	65	17·36
5400–6300	8	0·88
6300–7200	2	0·00
>7200	1	trace

These two tables are not directly comparable on account of the strong terrigenous character of the deposits of the basins of the East Indian archipelago. Nevertheless they show clearly how in the basins from a depth of 3500 metres downwards the percentage of carbonate of lime rapidly decreases and soon becomes smaller than in the oceans. Whereas below 4000 metres in the basins the majority of the samples are completely limeless, and the average percentage from all the samples is as low as 2·1, in the open oceans between 4500 and 5400 metres the percentage of carbonate of lime in the deposits averages 17·36, and the practically limeless zone only commences at a depth of about 5500 metres.

Böggild—although "with strong hesitation"—applies the name "red clay" to the limeless deposits found in the deepest portion of the Celebes basin and the Banda basin, although these deposits, the carbonate of

lime being dissolved, are practically no more distinguishable from either blue mud or volcanic mud. This name is apt to cause confusion, because the red clay of the oceans has a well-marked geological character of its own, having far more than any other deposit accumulated with extreme slowness. Böggild's red clay of the enclosed basins lacks this and any other geological character of its own.

This disappearance of the carbonate of lime in the deeper portions of the more or less enclosed basins is an unexpected result. The current opinion is that the progressive solution of carbonate of lime in the oceans with increasing depths must be attributed to the influence of the cold water of the polar regions, which by the hydrospheric circulation slowly but continuously replaces and refreshes the deepest sheets of water at the bottom of the oceans. This water contains a large percentage of oxygen in solution, and thus maintains the power of the deeper portions of the oceans to oxidize organic matter. The carbonic acid freed by this process of oxidization would give the same deep water the power to dissolve carbonate of lime, and thus to destroy those descending shells and skeletons of dead pelagic organisms which are composed of carbonate of lime.

Now, in the Banda basin and the Celebes basin, which are separated from the Molucca passage and thus from the Pacific Ocean by ridges of no greater depth than 1650 and 1400 metres respectively, the deeper water of the oceans which is richest in oxygen and carbonic acid has no access. Thus, according to generally accepted views the percentage of lime even in the deepest portions of these basins could not be less, or at least not much less, than in the Pacific Ocean in depths corresponding with the lowest point of the separating ridges.

Consequently, one would expect to find in the deposits in the deeper homothermic portions of these basins a rather large percentage of carbonate of lime, 50 per cent. or more. Böggild's analyses have shown that this is not the case. Böggild looks for local explanations, and suggests the possibility of the occurrence of submarine volcanoes as sources of carbonic acid, but this suggestion is not sustained by facts.

A similar case has been recorded from a portion of the Caribbean Mediterranean Sea, which huge basin from a depth of 1200 metres downward is separated from the Atlantic Ocean. Here in the Curaçao deep* at depths of about 5000 metres limeless deposits (red clay) are said to occur, whereas in another still deeper portion of the same basin, viz. in the Bartlett deep, the presence of pure Globigerina ooze is indicated. Our information about the deposits in the Caribbean Sea, however, is scanty as yet, and I have not succeeded in finding a discussion of the quoted occurrence of red clay in the Curaçao deep. The entire

* J. Murray and E. Philippi (Bibl. 16, Map i.); J. Murray and J. Hjort (Bibl. 17, Map iv.). A. Agassiz maps the bottom deposit in the Curaçao deep as a modified pteropode ooze (Bibl. 1, vol. 1, Fig. 191).

question of the occurrence of limeless deposits in enclosed deep-sea basins appears to be as yet open to explanation. According to what has been said above, one must expect these deep sea-basins, and in general the complicated submarine topography, of which they form the most conspicuous features, to be of modern origin. Before discussing their mode of origin it will, however, be found useful also to take into consideration what characteristics modern hydrographical research has disclosed in those other positions of the archipelago, where deep-sea basins do not occur. Here an entirely different aspect prevails.

Two great shelves attached to the continents of Asia and Australia extend far into the archipelago, as has been stated by Early (Bibl. 8, p. 395) in this *Journal* as early as 1845. They are known as the Asiatic bank or Sunda shelf, and the Australian bank or Sahul shelf. The Sunda shelf is the greatest shelf known on earth, measuring 1,850,000 square kilometres. The surfaces of both the Sunda shelf and the Sahul shelf are characterized by their almost perfect evenness. The depth of the water on these banks averages about 30 fathoms (W. Earle, Bibl. 8, p. 359). On the Sunda shelf depths exceeding 30 fathoms are extremely rare, and practically are only found in the south-eastern portion, where in the direction of the Makassar strait the depth increases rapidly; and again in the north, where towards the South China Sea the depth increases very slowly. A constant depth and a perfectly even and undisturbed surface of their bottoms are the outstanding features of these shelf seas. Thus the East Indian Archipelago proves to consist of two strongly contrasting portions (R. D. M. Verbeek, 24, p. 797), one with an exceptionally uniform and undisturbed submarine topography, and another with an extremely complicated structure.

Great as is the contrast between those two areas with regard to their present physical features, no less is this the case with regard to their geological history, as I have shown elsewhere (Bibl. 11, p. 232). The area to which the shelf seas belong, at least since the close of the Pliocene Age, has been stable, and thus has not been disturbed by any orogenetic movements, whereas the area to which the deep-sea basins belong since that time has continued to be unstable and orogenetically very active.

The Shelf Seas and the former Sunda Land.—The almost perfect uniformity in depth of those shelf seas suggests that they are originated by changes of the sea-level rather than by diastrophism. In the year 1916 (Bibl. 13, p. 612) while discussing Daly's glacial-control theory (Bibl. 7) and again in the year 1919 (Bibl. 14, p. 404) the author has given his ideas on the causal relation between the origin of those shelf seas and the Pleistocene glaciation, which will be referred to shortly here, as far as the Sunda shelf is concerned. At the end of the Pliocene period or at the beginning of the Pleistocene Age the present Sunda sea probably consisted of low land or a group of islands. One might imagine an imperfect

peneplain partly covered by the sea. At the beginning of the Ice Age the sea-level sank in consequence of the growth of the Pleistocene icecaps (see Penck, Bibl. 19 and 20; Daly, Bibl. 6 and 7) and stood at least 40 fathoms lower than at the present day. A great area was laid dry and united the present islands of Sumatra, Borneo, and Java. This land is called the Sunda land. This Sunda land probably has existed as a stable continental landmass at least since the beginning of the Neogene Age.

During the Pleistocene Age a period of long-continued erosion followed. This process was active, the erosive power of all the streams and rivers having been intensified by the lowering of their base-level. Then an extensive gradation-plane was formed, from which only here and there exceptionally resisting portions protruded as groups of rounded hills or monadnocks. The broad peneplain was bordered to the west, south-west, and south by the partly volcanic, partly non-volcanic high mountains of Sumatra and Java; towards the north, north-east, and east by the huge granite bosses, the high sandstone plateaus, and the older mountain chains of Borneo. In this peneplain the rivers which flowed from the mountains united into two or more powerful streams, which discharged probably into the South China Sea and into the southern shallower portion of the strait of Makassar.

At the end of the glacial period the sea-level rose again to its present height consequent on the melting of the ice-caps. The Sunda peneplain was gradually submerged and for its greater part converted into a shelf sea, the great Sunda-shelf sea. The monadnocks, few in number, were isolated by the rising sea and now form groups of rocks and islands, emerging from the shelf sea, as for example Bangka, Billiton, Singkep, the islands of the Riow archipelago, the Karimata islands, the Karimon Java islands, and others.

This is of course a much simplified conception of what has happened in reality. The Ice Age has not been one single cold period, but a succession of colder glacial periods alternating with milder interglacial periods. Consequently the ice-caps more than once have grown to a large extent and have melted again. Thus we may surmise that during the first glacial period the Sunda peneplain, which probably already pre-existed in an imperfect state, has recommenced to develop; that it has been covered by the sea during the first interglacial period; that during the second glacial time it was rendered more perfect; that it was flooded again during the second interglacial time, and so on, until the last glacial period saw the peneplain in such a state of perfection, as is now illustrated by the floor of the Sunda-shelf sea.

If this theory holds good one must expect to find evidences of recent subsidence all along the coast of the Sunda sea. This is indeed the case. First of all, the land up to a great distance from the coast is flat and no traces of upheaved modern coastal formations of any importance are

known. The even surface of the shelf is prolonged without altering its character far into the interior in the low peneplainized country surrounding the major portion of the Sunda sea. Along the western coast of Borneo a retreat of the sea to a depth of 10 fathoms would connect no less than eighty smaller and larger islands * with the main land, and their higher portions with their smooth contours would be incorporated into the still

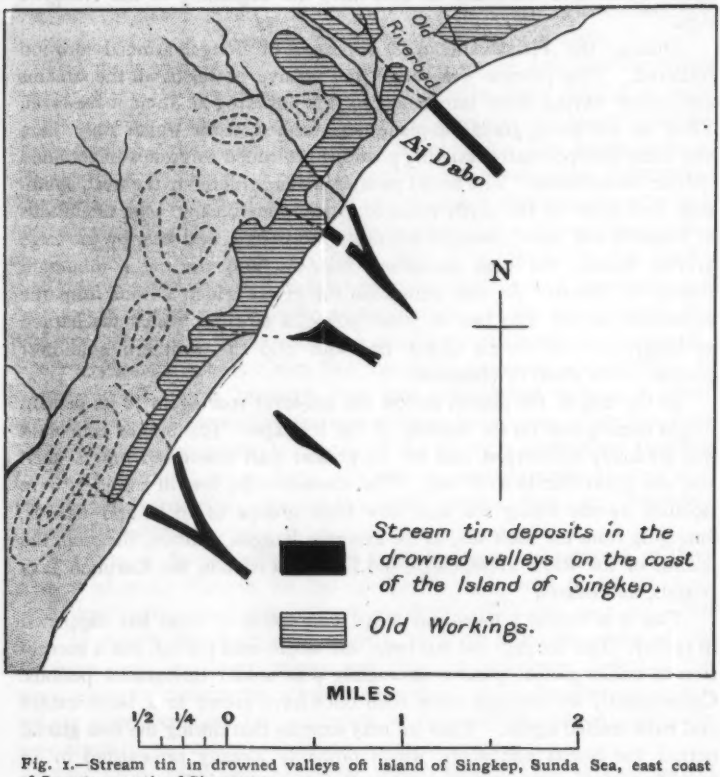

Old Riverbed
Aj Dabo
N
Stream tin deposits in the drowned valleys on the coast of the Island of Singkep.
Old Workings.
MILES
1/2 1/4 0 1 2

Fig. 1.—Stream tin in drowned valleys off island of Singkep, Sunda Sea, east coast of Sumatra, south of Singapore

unflooded portion of the extensive peneplain of West Borneo without the scenery of the landscape being altered in any perceptible degree.

Further, deltas are generally wanting, although the rivers both of Borneo and Sumatra transport heavy loads of sediment towards the sea; only two of them, the Pawan and the Kapuas, have built out a delta which, however, even in the case of the Kapuas, which carries more sediment than any of the other rivers, hardly protrudes from the coast-line into the

* Not including low alluvial islands, exclusively composed of modern detritus.

sea. In general the coast-lines are embayed, and the rivers possess wide funnel-shaped mouths with great depths in their lower courses. The submarine continuations of these rivers, *i.e.* their drowned portions, can

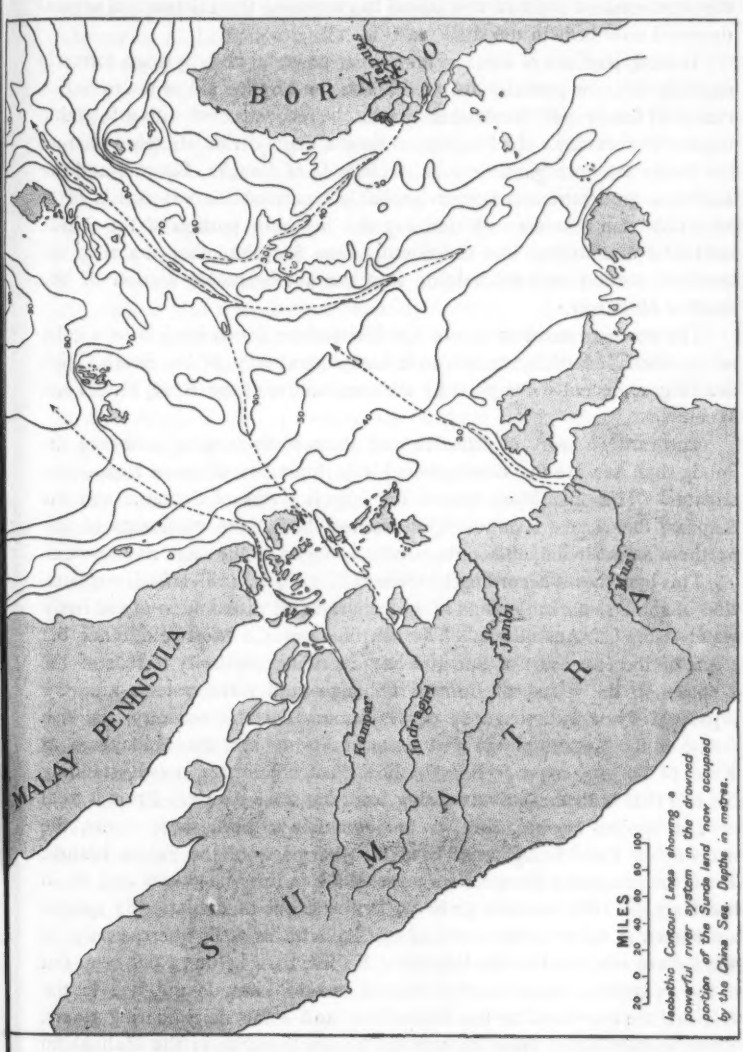


FIG. 2.—ANCIENT RIVER-SYSTEM OF THE DROWNED SUNDA LAND
[*From the map compiled by Commander H. M. van Weel*

be traced in many instances. Thus the submarine course of the Sampit river can be traced to a distance of 35 kilometres from the coast as a shallow gully in the shelf. On the island of Singkep the tin ore deposited

in the lowermost strata of the alluvium in the river-beds has been followed as far as 1300 metres out from the coast, lying at a depth of 9½ fathoms (17 metres) below sea-level. The exploitation of this so-called sea-tin on the south-eastern coast of this island has revealed the existence of several drowned river-beds in the shelf sea (Fig. 1).

Indeed, portions of some of the former powerful river systems formerly draining the now partially drowned Sunda land by the aid of the isobathic curves of the present Sunda-shelf sea can be reconstructed with a tolerable degree of accuracy. In Pleistocene time a main divide stretching across the Sunda sea from Sumatra over the islands of Bangka, Billiton, and the Karimata group towards Borneo probably separated the watersheds of at least two main streams, one draining the northern portion of the Sunda land and discharging into the South China Sea, the other draining the southern portion and discharging into the southernmost section of the strait of Makassar.

The northern main stream of the Pleistocene Sunda land is as a gully in the shelf beautifully shown on a bathymetric map of the South China Sea (Fig. 2), recently compiled by the commander of the *Brak*, H. M. van Weel.

The various rivers of Sumatra and Borneo discharging now into the Sunda-shelf sea are the dismembered side branches of these large main streams. Thus the Musi, one of the largest rivers of Sumatra, and the Kapuas, the largest river of West Borneo, both were confluents of the northern main stream, and consequently belonged to the same river system.

This hypothesis, according to Weber (Bibl. 14, p. 428), affords explanation of some remarkable facts in the geographical distribution of the freshwater fishes of Australasia. The fish fauna of the Musi and other big rivers of the east coast of Sumatra has a striking similarity to that of the Kapuas on the island of Borneo, although both river systems are now separated by a wide expanse of sea-water. On the contrary, the fish faunæ of the Kapuas of the west coast of Borneo and the Mahakkam or Kutei of the east coast of Borneo show great differences, notwithstanding the fact that both these rivers spring from the same divide. From a total of 142 species known, only 52 are common to both these rivers, the majority of these being found also in other parts of the Sunda islands. From the remaining 90 species 23 are found in the Mahakkam and 67 in the Kapuas. No less than 52 or 75 per cent. out of the latter 67 species are known to occur in the rivers of east Sumatra as well, whereas only 12 species are restricted to the Kapuas. No less than 17 or 74 per cent. out of the 23 species which occur in the Mahakkam, but do not live in the Kapuas, are restricted to the Mahakkam and some neighbouring rivers. Three species out of these 23 only are known to occur in the Mahakkam as well as in the rivers of East Sumatra. Thus the Kapuas owes its superiority in number of its fish fauna as compared with that of the Mahakkam, not to its autochthonic species, but to those species which it

has in common with the rivers of East Sumatra. These facts tend to make probable a former connection between the river system of the Kapuas and the rivers of East Sumatra, which according to the hypothesis explained above must have existed in Pleistocene time before the gradual submerging of the Sunda land.

Finally, a direct proof of the said immersion is given by the magnificent barrier reef which marks the position of the east coast of the submerged Sunda land. This reef, which appropriately may be named the Great Sunda barrier reef (Fig. 3), extends roughly parallel to the south-eastern coast of Borneo, from the Ambungi coral island 120 kilometres south of the mouth of the Kutei or Mahakkam river to a point in 5° 40′ South lat. over a length of about 500 kilometres. From Ambungi island it first runs in a south-easterly direction to a point just opposite cape Ongkona on the island of Celebes. From here it turns sharp into a south-westerly and further into a south-south-westerly direction. At the bend opposite cape Ongkona it is 230 kilometres distant from the nearest point of the coast of Borneo, and only 44 kilometres from the coast of Celebes. In a westward direction towards Borneo the depth of the lagoon is very uniform, in the average about 45 metres and nowhere more than 75 metres; eastward of the reef towards the island of Celebes the depth of the sea increases abruptly to 200, from there rapidly to 1000, and thence in a small distance to 2385 metres. The barrier reef is interrupted at many places, and its separate coral islands only here and there reach the surface of the sea. A well-marked row of coral islands, the so-called Laurel reefs, constitutes the southern portion of this long barrier reef.

As stated above, the barrier reef ends at about 5° 40′ S.; then follows a gap of 100 kilometres in width facing a deep embayment of the former Sunda land, into which most probably one of the main watercourses draining that country discharged and deposited a portion of its sediments. More to the south the barrier reef reappears in the Kwong–Eng reef, and can be followed from there as far as the Kangeang islands.

This great barrier reef evidently originated from a fringing reef which in late Pleistocene time extended along the east coast of Sunda land. With the gradual rise of the sea-level after the close of the glacial period and the gradual immersion of the Sunda land the reef has grown up and in many places succeeded in maintaining its position at or near the sea-level. This barrier reef until lately (J. F. Niermeyer, Bibl. 18, p. 884 and Map. xiii. 2) has not been recognized as such, mainly on account of insufficient knowledge of the depths of the sea in the strait of Makassar, and also on account of its exceptionally great distance from the coast to which it belongs. The large atolls in the southernmost portion of the strait of Makassar are probably originated by the submersion of islands belonging to the Sunda land (Bibl. 14, p. 421).

On the northern coast of the former Sunda land no barrier reef in the present South China Sea is found indicating the position of the

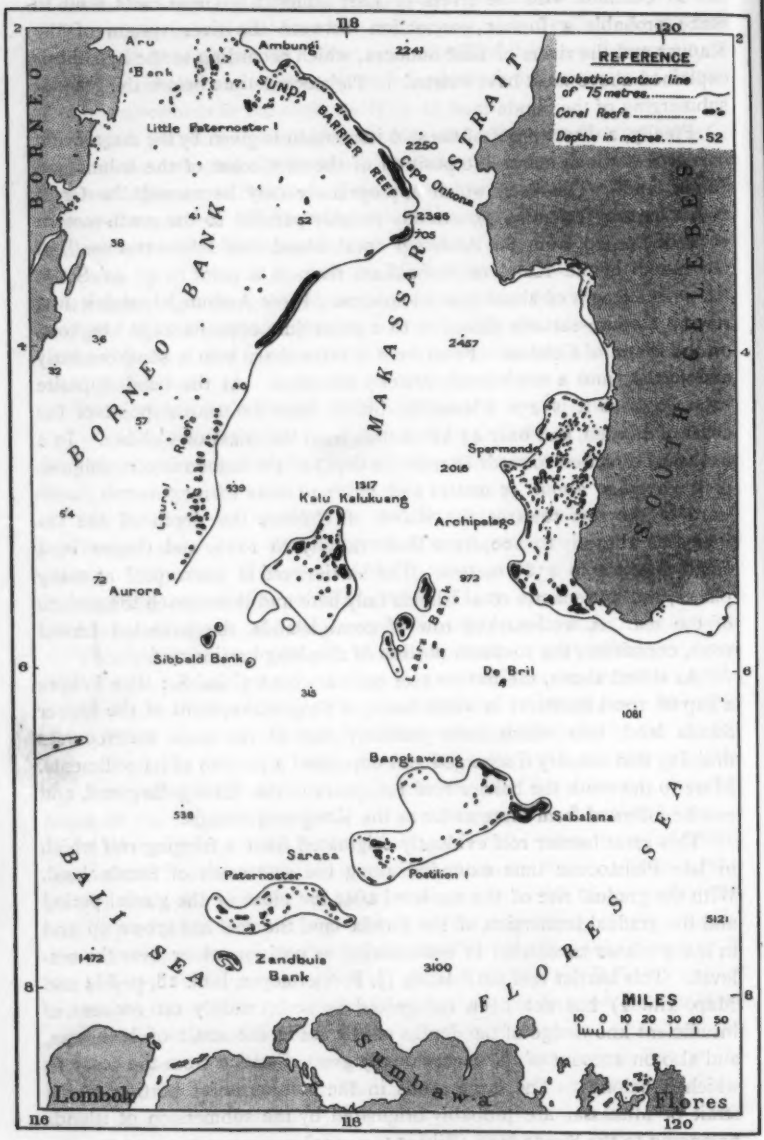


FIG. 3.—THE GREAT SUNDA BARRIER REEF AND ATOLLS

Pleistocene coast-line. A plausible explanation of this fact is that in Pleistocene time, as is revealed by the present isobathic curves, the land on this coast was very flat and merged gradually into an extensive shelf, which, consisting of loose sand and muddy sediments, probably did not offer favourable conditions for the development of fringing reefs.

The Sahul Shelf.—The Sahul shelf has much the same geological history as the Sunda shelf. In late Pleistocene time the mainland of Australia was connected with New Guinea and the Aru islands by a flat land, probably a peneplain. After the close of the glacial period this low-lying country was flooded by the general rise of the sea-level, and has been converted into the present Sahul shelf.

I have not been able to collect sufficient data to unravel the geological history of this shelf in detail. I shall confine myself, therefore, to this remark, that at many places the position of the Pleistocene coast-line appears to be indicated by coral islands, and that the present shore-line of north-west Australia, as well as that of the south coast of the western portion of New Guinea, is deeply indented. The fiord-like lower course of the Prince Regent River (J. W. Gregory, Bibl. 9, p. 348) presents a typical example of a submerged or drowned valley.

The Deep-Sea Basins and their Surroundings.—The geological history of that portion of the East Indian archipelago to which the remarkable deep-sea basins are confined is quite different from that of the stable portion which has just been dealt with. Although the topography both of the land and the sea-bottom is very complicated, a few main features stand out well, and cannot fail to attract attention. These features are the well-marked trough-shape of the majority of the deep-sea basins, the elongated form of nearly all the islands bordering on these basins, their elongation being in the same direction as that of the troughs; the arrangement of both the basins and the islands in curved rows; and the conspicuous signs of elevation in modern times exhibited by those islands.

It is reasonable to surmise that a genetic connection must exist between the subsidence of the trough-shaped deep-sea basins and the elevation of the adjoining elongated islands; indeed, the common origin of these antagonistic movements, according to my opinion, has to be sought in one and the same crustal movement, viz. in a process of folding at a certain depth. If the question were raised as to what might be seen at the Earth's surface if an area were folded by crustal movement at a certain depth, I should be inclined to reply that its appearance would be similar to what obtains at present in the eastern portion of the Indian archipelago (Bibl. 11, p. 231).

Near the surface alternating zones of subsidence and of elevation are found, and the ranges of trough-shaped deep-sea basins mark the position of the synclinal axes, whereas the ranges of elevated islands mark the position of the anticlinal axes of the major folds, which are in process of formation at a certain depth. Deep-sea research has proved that these islands, for

example, those of the non-volcanic range encircling the central Banda sea, stand on a well-marked continuous submarine ridge with a fairly uniform depth of 800–1500 metres, and that they are generally separated from each other by deep channels often of considerable width. These facts ask for explanation.

As soon as the upper portions of the folds which develop at a certain depth approach the Earth's surface and the majority of the rocks under diminished pressure can no more be folded without being fractured (*van Hise's* zone of fracture), the continuity of the strata will be broken and the culminating portions of the elevating anticlinal axes will be fractured and show at the surface as isolated portions or blocks, their extent and shape being greatly dependent on the geological structure and the differences in rigidity of the composing rocks. This may suffice to explain why an elevating submarine ridge formed by an anticlinal axis will appear at the surface as a row of blocks, *i.e.* islands separated by deep channels.

But this alone would not yet explain the great width of many of the straits between the islands. Here another factor still may play a rôle (H. A. Brouwer, Bibl. 5). It is an established fact that arcuate anticlinal ridges during their devolopment generally shift their axes in an outward direction, and thus progressively cover more and more ground. The tension resulting from this movement will not interfere with the continuity of the ridge at a certain depth where plastic deformation of the rocks can take place, but near the surface will break up the upper portion of the anticlinal ridge into blocks of different sizes which will be separated by gaps. These blocks may moreover shift their position with regard to each other over more or less considerable distances. Thus a somewhat irregular curved row of islands, resembling the ranges encircling the central portion of the Banda sea, may be formed, the islands being separated one from the other by gaps of varying and often great depths.

In the great geosynclinal area between the continents of Asia and Australia one arc of folding belonging to the Alpine system, and known as the Malay arc, appears to originate from the Burma arc, the south-easternmost range of the Eastern Himalayan system, and can be followed through the domain of the East Indian archipelago from the extreme north-western end of Sumatra, through this island and the island of Java, and from there in a double row of islands as far as the Banda sea.

In its western section where it borders on the Indian Ocean, as in the central portion of the island of Sumatra, this arc now consists of two major folds, as is illustrated by an ideal cross-section (Fig. 4) *.from the Indian Ocean towards the stable portion of the Sunda land. It would show the following sequence :

* Verbeek has first recognized that these major folds, which date from pre-Tertiary time in their successive phases of development, always have determined the principal features of the geological structure of Sumatra. Bibl. 23, pp. 543–550, and figs. 50–55.

1. Indian Ocean.
2. Sunda trough, first geosyncline.
3. Range of coastal islands girdling the west coast of Sumatra including the Mentawei islands, first geoanticline.
4. Mentawei trough and corresponding trough-shaped depths, second geosyncline.
5. Non-volcanic and volcanic mountain ranges of Sumatra and Java, second geoanticline.
6. Tertiary terrain, folded in late Tertiary and early Pleistocene time, now practically stable, third geosyncline.
7. Stable Sunda land, including the Sunda shelf.

In this western portion the position of the following deep-sea basins is determined by the present phase of the process of folding:

1. The Andaman basin.
2. The Mentawei trough.
3. The Sunda trough.

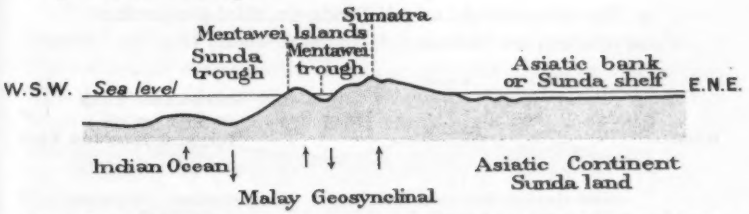


Fig. 4.—Schematic representation of late Tertiary Pleistocene and post-Pleistocene crustal movements in the western section of the Malay or Australasian geosynclinal area

In the south-eastern section of the same arc the process of folding has been modified by the proximity of the stable Australian continent and the thrusting against its edge.

In its easternmost section in the Moluccas the crustal warping is of an extremely complicated nature on account of the fact that two great orogenetic systems, the Alpine system and the circum-Pacific system,* here meet and are interlaced. The Malay arc belonging to the Alpine folding system in the Moluccas is represented by two more or less parallel curved rows of islands, the inner being volcanic, the outer non-volcanic. After having curved round the Banda sea, it is completely rolled on itself and disappears in the Banda basin (H. A. Brouwer, Bibl. 3). The last island of the non-volcanic row appears to be the island of Buru, and the volcanic row appears to end in the Banda group or possibly beyond the shoals of the Lucipara group in the Gunung Api.†

* This is the current opinion endorsed by E. Haug and P. Sarasin. It remains, however, open to discussion whether it would not be more recommendable to distinguish between a circum-Asiatic system and an Australo-Pacific system.

† There is some reason to surmise that the Ceram-Buru arc being broken off west of Buru might have its continuation through the Tukang Besi islands, and from these through Buton and the portion of Celebes east of the Boni-Posso depression.

The major folds of the Malay arc in its eastern section determine the position of the following sea basins and ranges of elevated islands.

I. Australian continent and Sahul shelf.

II. Folds of the Malay arc.

1. Timor trough, Kei trough, Ceram-Aru trough, Ceram sea, first geosyncline.
2. Row of fifteen larger and numerous smaller non-volcanic islands ranging from Sumba over Timor to Buru, first geoanticline. This curved row, after its most important constituents, is also known as the Timor-Ceram row, or the Timor-Ceram arc.
3. Savu sea, Wetter trough, East Banda trough including the Weber deep, second geosyncline.
4. Row of eight larger and numerous smaller volcanic islands and rocks, ranging from Bali over Alor and Wetter to the Banda group, possibly to the Lucipara shoals and Gunung Api, second geoanticline.
5. Flores sea and the central Banda sea, third geosyncline.

These relations are illustrated in an ideal section (Fig. 5). More to

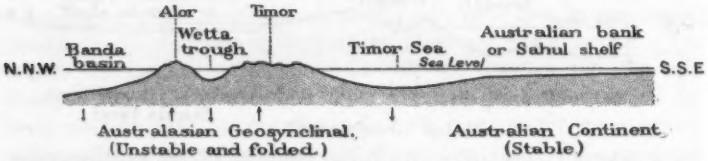


Fig. 5.—Schematic representation of Pleistocene and post-Pleistocene crustal movement in the eastern section of the Australasian or Malay geosynclinal

the north the position of the majority of the deep-sea basins of the East Indian archipelago has been determined by the major folds in the geosynclinal area bordering on the east coast of Asia and belonging to the circum-Pacific system. It appears that the remarkable basins of the Sulu sea and the Celebes sea, including the Strait of Makassar, are modified troughs lying between anticlinal axes fanning out from the Philippine islands towards the south (W. D. Smith, Bibl. 21).

The tectonics of North Borneo, the Philippines, and New Guinea are however, as yet little known, and it would be hazardous to enunciate speculative ideas on the relations between the deep-sea basins of the northern and north-eastern portion of the East Indian archipelago and the marginal folding in the Pacific Ocean along the coast of the Australian continent and of New Guinea.

Distribution of Coral Reefs.—The distribution of coral reefs and coral islands in the unstable or geosynclinal portion of the East Indian archipelago is well in harmony with the theory the brief outlines of which are given above, according to which both the deep-sea troughs and the ranges of islands separating them are in their present shape the result of one and

the same process of folding in the earth's crust in Pleistocene and post-Pleistocene time, which most probably still continues.

The first conspicuous fact is, that the islands in this region of complicated topography which in general mark the position of the main anticlinal axes almost without exception are fringed by reefs and possess a terraced appearance caused by extinct coral reefs being elevated to various heights. To quote an instance, in the interior of the island of Timor coral reefs of Pleistocene age are found elevated to a height of nearly 1300 metres above sea-level. Kisser with its terraces is one of the finest specimens of a terraced island. On several other islands the number of the elevated terraces is higher still, viz. thirteen on Kambing, fifteen on Dai, and sixteen on Dawara, according to Verbeek. The process of elevation is most probably still going on. This is exactly what the theory requires. Another not less conspicuous fact, that the trough-shaped deep-sea basins separating the ranges of elevated islands one from the other are, taken as a whole, free of barrier reefs and atolls, asks for a special explanation.

Undoubtedly the fact that these basins, marking the position of the synclinal axes, and thus indicating areas of subsidence, do not possess reef types which are characteristic of such areas appears to be in contradiction with the theory advocated above. If, however, one bears in mind that more than anything else the latest crustal warping has resulted in the emerging of ranges of islands from the sea in the anticlinal areas and in the deepening of pre-existing shallow seas in the synclinal areas, a plausible explanation can be given.

Before the latest still continuing phase of the orogenetic movements set in, the general topography of the eastern portion of the archipelago as a result of an anterior folding of probably late Miocene age resembled the present one, with this material difference, that the sea-basins were much shallower than they are to-day, and that the islands were lower and smaller. In fact many of the latter were entirely submerged and did not yet exist as such. The Pleistocene and post-Pleistocene folds described here are probably engrafted upon the older Tertiary folds.

During the process of emersion the islands continually grew larger and finally attained their present size. Fringing reefs were continually formed along the coasts during this period of upheaval, and began to be elevated as soon as they had been formed. Where they have not been destroyed later by erosion they now form part of the elevated terraces. The islands thus growing at the cost of the sea-basins, there was practically no chance for any of the fringing reefs to become converted into a barrier reef.

In this line of reasoning one has, of course, to take for granted that the pre-existing former shallower seas were free from islands and shoals. A strict proof of the accuracy of this postulate cannot be given as yet.

Fig. 6 is meant to illustrate schematically a possible mode of origin of the islands of the Moluccas with their elevated reefs, and of the deep-sea basins separating them which are devoid of barrier reefs and atolls.

Another alternative appears to be admissible. The pre-existing shallower seas may have possessed fringed islands or coral shoals, but these may have been drowned now. The downward movement caused by diastrophism in this case must have been so rapid that it could no more be compensated by the upward growth of the reef-building corals. A remarkable dredging carried out by the *Siboga* on 1 September 1900 in the deeper portion of the Ceram sea appears to give an instance. From a depth ranging from 1633 to 1304 metres over a distance of no less than 3 nautical miles large quantities of recent reef-building coral were then dredged, which had died off, and by a thick cover of manganese revealed their long stay in the sea-water after their dying off. The nearest point in these regions where living reef-building corals occur near the surface lies at 42 kilometres from the point where the dredging took place, so that those corals in the deep sea could not originate there. In order to explain the result of this dredging, I should rather suppose that on that spot in the

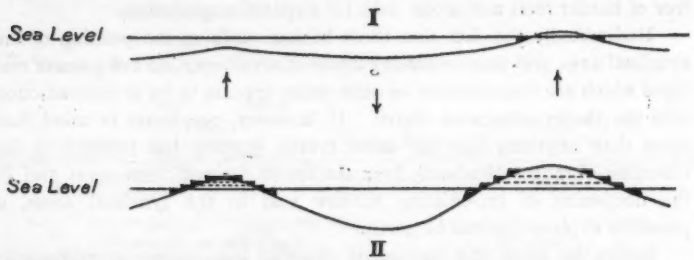


Fig. 6.—Ideal cross-sections illustrating the mode of origin of the deep-sea basins and the elevated terraced islands of the Moluccas by recent deep-seated folding. I. Before the folding. II. After the folding. Coral reefs: Black

Ceram sea from the sea-bottom, which lies at a depth of about 1600 metres, a drowned coral island rises to about 1300 metres below sea-level.

Accepting this alternative, one is led to surmise that one of the reasons why the present deep-sea basins of the East Indian archipelago, although formed by subsidence, are free from reef structures of the types of barrier reefs and atolls, is that these reefs have been drowned. Detailed deep-sea research may throw in future more light on this subject.

Some exceptions, however, are known to exist within the area concerned. A few barrier reefs and atolls are found in the basins of the unstable portion of the East Indian archipelago, as well as along the south-western coast of Sumatra, as in the archipelago of the Moluccas. I will quote a few instances from the latter region only. The group of islands south-east of Celebes, known as the Tukang Besi islands (Fig. 7), consists of four rows of islands, trending about from north-west to south-east. Two of these ranges consist of upheaved islands terraced by elevated reefs and girdled by well-developed fringing reefs; the two remaining ranges which alternate with the former consist of small rock groups without traces of

elevated reefs encircled by barrier reefs, and of atolls or atolliform coral islands (Bibl. 10).

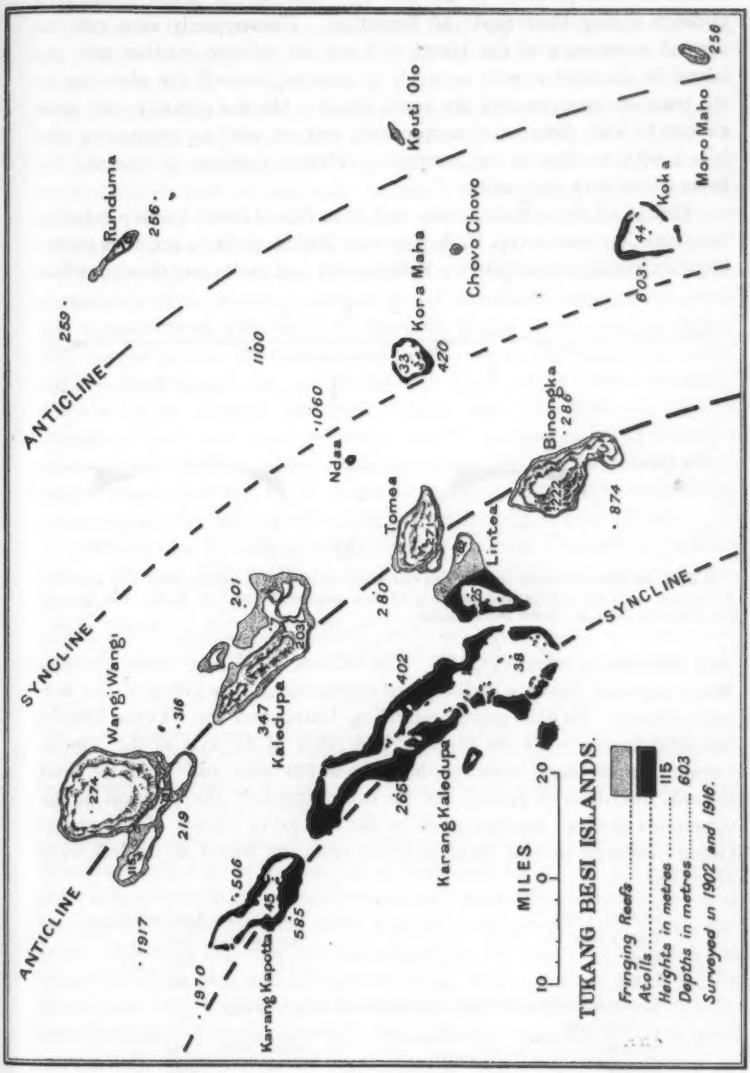


FIG. 7.—FRINGING REEFS ON THE ANTICLINES AND ATOLLS ON THE SYNCLINES, TUKANG BESI ISLANDS

Evidently in this case the terraced islands mark the anticlinal axes and the reef-encircled islands and atolls the synclinal axes of an area of active

folding at a certain depth. Some other instances are equally interesting, because they show how the development of the reefs on and along the anticlinal axes partakes of all the modifications in shape these axes undergo during their mode of formation. Consequently as a rule the upward movement of the island will not be uniform, neither will one island be elevated exactly as much as another, nor will the elevation be the same all over one and the same island. On the contrary, one must expect to find differential movements, just as well on comparing one island with another as on comparing different portions of one and the same island with each other.

First of all, the anticlinal axis may in its line of trend develop culminations and depressions (cp. H. A. Brouwer, Bibl. 4, p. 820), and thus show a more or less important pitch. Barrier-reefs and atolls may develop where

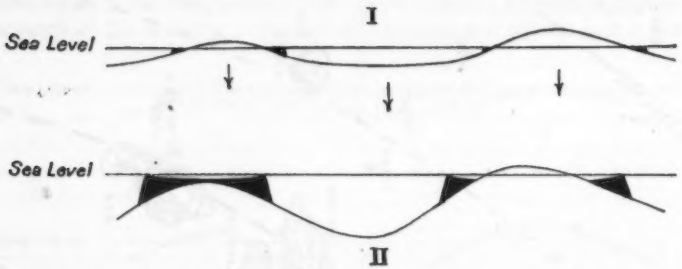


Fig. 8.—Ideal cross-sections illustrating the mode of origin of barrier reefs and atolls in anticlinal areas by folding and pitching of the anticlinal axis. I, Before the folding. II. After the folding. Coral reefs: Black

such depressions occur (Fig. 8). The axis of the Timor-Ceram (Sumba-Buru) anticline shows a well-marked depression in the group of the Sermata islands. In this group, encircling Luang and the Ukenas islands, beautiful barrier reefs are found. The pitch of the axis of the Timor-Ceram (Sumba-Buru) anticline, both from the west and from the east towards the island of Luang, can be calculated from the position of the uppermost elevated modern reefs in the adjoining islands of the range. Going from west to east these elevated reefs are found at the following altitudes:

Central Timor	1300	metres
East Timor ... ... estimated	600	,,
Letti	140	,,
Lakor	20	,,
Luang and Ukenas islands: no elevated reefs, no fringing reefs		
Sermata ... ... submersion	400	,,
Babber ... . ,,	650	,,

Sometimes a submarine anticlinal axis pitching downwards can be followed by the position of coral islands which have grown up from its

submerged portion. Thus probably the Lucipara coral shoal marks the continuation of the submerged volcanic range of islands, Wetter-Banda, in the central Banda sea.

Secondly, the bend of the anticlinal axis may be accentuated during the process of upheaval, which in a normal case of folding will often occur. The uprise in such a case is no more uniform, and the elevated reefs are no longer found in a horizontal position, but more or less sloping. The island of Timor furnishes a good example, as I have shown (Bibl. 11, p. 228, and 12, pp. 693–696). The coral reefs are differentially elevated on this island; reefs of one and the same age, which in places are still coherent along the central axis of the island, are much more elevated than those nearer to the north and south coasts.

In fact, the reefs of the Dirun ridge south of the Lakaän near the central axis of the island occur now at an altitude of 1283 metres, about 680 metres higher than those on the hills of the north coast at Balbo. The big reef also of the Gempol cliff in the central portion of the island not far from Kapan has an altitude of 1250 metres above sea-level, whereas in the southern mountain ranges near Niki-Niki the highest altitude at which coral reefs are found is only 750 metres. The elevation of the central portion of the island has been from the beginning somewhat stronger than that of the southern and northern coastal regions, the entire island thus forming the feebly curved arc of a large anticline.

Furthermore, the axis of the developing anticline can shift its position (H. A. Brouwer, Bibl. 4, p. 822), which will cause tilting and unsymmetrical

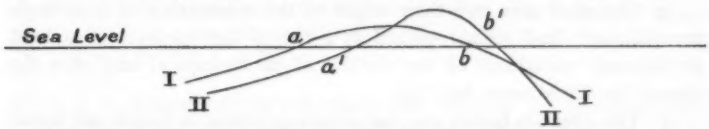


Fig. 9—Successive stages of development of an island situated on an anticlinal axis. Fringing reef formed at *a* and *b* during Stage I. would be found at *a'* and *b'* in a later Stage II. The fringing reef at *a* (Stage I.) would have been submerged and a barrier-reef have developed at *a'* (Stage II.), whereas the fringing reef at *b* (Stage I.) would have been elevated and been found at *b'* (Stage II.).

development of the elevated reefs. Such a shift of the axis can coincide with alterations in the dip of the sides of the anticline (Fig. 9), and the result can be the development of a barrier reef at one coast of an island, whereas at the opposite coast simultaneously fringing reefs are elevated above sea-level. Thus in this case simultaneously on the coasts of one and the same island fringing and elevated reefs as well as barrier reefs can be developed. On the islands of Roti and Sumba the reef terraces are distinctly tilted and unsymmetrical. The island of Jamdena offers a good example of subsidence at one coast, the northern coast, and upheaval at the opposite coast.

Finally, it may be pointed out that on studying the occurrence and the distribution of coral reefs in the unstable or orogenetically active portion

of the East Indian archipelago, one must not lose sight of the fact that the oscillations of the sea-level in connection with the Ice Age have taken place here just as well as in the stable Sunda land. These oscillations may probably give an explanation of the origin of some of the barrier reefs which occur along the coasts of some of the islands adjoining deep-sea basins, as has been shown by Niermeyer (Bibl. 18). Only the effect of these oscillations has been modified or totally overwhelmed here by that of the orogenetic forces, whereas in the stable Sunda land it is shown as such and unmodified.

To sum up, the latest researches on the geological history of the deep-sea basins of the East Indian archipelago and of the islands connected with them, have led to the following conclusions and suppositions:

1. The Australasian Mediterranean Sea consists of two strongly contrasting areas, one with an exceptionally uniform and undisturbed submarine topography, and another with an extremely complicated structure.

2. The first area is that of the great shelves, which are attached to the continents of Asia and Australia; the other that of the enclosed deep-sea basins.

3. The area of the shelf seas has been stable and has not been affected by diastrophism, at least since the end of the Pliocene Age. The area to which the deep-sea basins belong has since that time continued to be unstable as it was before, and has been, and is still, the seat of powerful orogenetic movements.

4. The shelf seas owe their origin to the submersion of a strongly peneplainized land surface caused by a rise of the sea-level of at least 40 fathoms, consequent on the melting of the ice-caps at and after the close of the Pleistocene Ice Age.

5. The deep-sea basins and the adjoining elevated islands are simultaneously formed, and continue to be developed by a process of folding at a certain depth.

6. The islands are elevated and grouped in rows because they are nothing but the culminating and fractured portions of submarine ridges which rise up on top of the anticlinal portions of the deep-seated folds. The trend of each row of islands roughly indicates the line of strike of the anticlinal axis of each of these folds.

7. The deep-sea basins are elongated more or less exactly parallel to the adjoining rows of islands, because they are formed above the subsiding synclinal portions of the deep-seated folds.

8. All the islands are, as a rule, upheaved, but the upheaval has been very unequal, as can be observed if the islands are compared one with another, or if a comparative examination be made of different portions of one island. In exceptional cases the upheaval is wanting, and even subsidence may occur instead, as has been explained above.

9. The consecutive phases of development of the anticlinal portions of

the folds are revealed at the surface by the mode of development of the reefs, and can be studied by comparing the character and the relative position of extinct reefs of the same age,

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Before the paper the PRESIDENT said: The lecturer this evening is Dr. Molengraaff, who is the head of the Geological Laboratory at the Technical Institute, Delft. He has paid three long visits to the Dutch East Indies and travelled in the interior of Borneo and Celebes, and is one of the greatest authorities on that region. We and the Dutch, for many centuries, have been rivals in the East Indies, and I understand from Dr. Molengraaff's paper that he proposes that we should be rivals for many million years yet. He is going to give us an account of how the Himalayas of the future are arising out of the Dutch East Indian archipelago. In that part of the Indies over which we hold administration there are the highest mountains in the world, but Dr. Molengraaff will tell you how perhaps still higher mountains are at this very moment emerging from out the ocean depths which may in course of time—I do not know how long—arise and rival the Himalayas. It is by great kindness on the part of Dr. Molengraaff that he is speaking to us here in England. He has taken the trouble to come over from Holland to read us this paper. He has not had much practice lately in giving public lectures in English, but I am sure you will all appreciate his consideration in speaking to us in our own language.

Dr. Molengraaff then read the paper printed above, and a discussion followed.

Dr. FRIDTJOF NANSEN: I am very unexpectedly called upon to speak to-night, and I can say only it is with the deepest interest I have listened, as I am sure we all have listened, to this most interesting lecture, and heard all these very important results that have been obtained by this hydrographical work in the East Indies. There is one part of this lecture which has appealed specially to me, as it covers much the same ground as I myself have been investigating, namely, the shelves of this Mediterranean sea of the tropics. It is one of the biggest submarine shelves in the world. There is another shelf of similar large extension, but formed in different circumstances, north of Siberia, which I had the very good fortune to investigate myself. The depths are, as far as I understand, very much the same; the configuration seems to be very similar, and the edge lies very nearly in the same depth. These are two of the greatest shelves in the world; the third is east of South America. The depth is to a great extent about 40 fathoms, or less than 100 metres. The shelf north of Siberia is something like 400 or 500 miles broad, and the sculpturing of the surface seems to be very much the same. You call it a peneplain. I think that is quite right, but it is a peneplain that at least in the north has to some great extent also been levelled by marine denudation. I don't know how far that is the case with the shelf in the south, but it is with the shelves of the Polar Sea. There the marine denudation is chiefly caused, in my opinion, by an action not possible in the tropics, namely by the frost. I think the frost on the shoreline is one of the chief reasons why the shelves on all sides of the Polar Sea are very broad—very broad north of Siberia, and I am sure we are not mistaken if we think it also very broad north of the unknown coast of the American continent.

We do not know yet its extension towards the north. This frost denudation has been very violent on account of the low temperature, which has caused the water and the ice and snow on the shore to alternately melt and freeze and made the sea eat gradually on to the land. The land has been denuded by the atmospheric erosion, and more or less transformed into a peneplain that is approaching the level of the sea, but I consider it quite impossible that the peneplain could be formed so perfectly level as these drowned plains really are. I understand from the map that the surface of this East Indian shelf is perhaps not quite so level. It is, however, remarkable that under so different conditions, as in the tropical sea, where the erosion is chiefly caused by chemical action at high temperatures, and the Polar Sea, where caused chiefly by the frost and low temperature, the results should turn out to be almost the same—shelves with nearly the same level surface and same features, and they are submerged about the same depth. They seem to indicate that there must have been a general rise of the sea surface during modern geological times. The chief reason for this must be that the volume of the sea has been increased partly by the melting of the great ice-caps of the Ice Age. The sea must have risen something like 100 metres, or 50 fathoms, because all the shelves in the world are submerged about that depth, and it is a remarkable feature, wherever we go we find an indication of this same shelf. I believe that we have here still a great field for future investigation that will tell us much about the past, I mean in modern times, of the oscillations of the sea-level and the land surface, and I congratulate the Dutch Government and people on the splendid results that these Dutch investigations in the East Indies have given.

Dr. J. W. EVANS: It gives me the very greatest pleasure to welcome my old friend Prof. Molengraaff. We have followed with the keenest interest and instruction what he has had to tell us this evening. He has taken us to one of the most critical portions of the whole crust of the Earth, where those two great lines of crustal weakness—the tract surrounding the Pacific and that which extends from east to west across Europe and Asia (what he calls the Alpine tract)—meet together, and there we find action of the very greatest importance proceeding. The surface of the Earth is like an ice-floe composed of great solid blocks which are always crumbling against one another. These blocks as a whole seem almost immune from any change, but in between them are very energetic movements. It was just one of these intervening regions which Prof. Molengraaff has been telling us about to-night. To the north is one of the solid floating masses; to the south another, and between them is an area subject to great lateral pressure, resulting in a series of folds; and Prof. Molengraaff has described to us in the clearest possible manner the evidence for the existence of these folds. Apparently at present, as far as I have been able to follow the lecturer, they are of a comparatively gentle character, more in the nature of undulations; and they therefore represent a very early stage in the history of mountain building. Many myriads of years must pass before these regions can rival the Himalayas in the complexity of their structure, and much must happen before then. There will be great thrusts from one direction or the other. At present I understand there is in the area described by Prof. Molengraaff very little evidence of this. If, on the other hand, we examine the remains of the old mountain ranges, formed when these islands were subject to movements similar to those now in operation in the Malay archipelago, but far more intense, mountain ranges which have long since been worn almost flat by atmospheric agency, we find there have been gigantic thrusts from the south which have piled up masses of the Earth's crust one upon

the other. I should like to thank Prof. Molengraaff very heartily for the interesting and instructive lecture he has given us to-night, and express the hope that it will be by no means the last we shall have from him at the Royal Geographical Society.

H.E. THE NETHERLANDS MINISTER: There has been every reason for me, as the President very kindly acknowledged, not to put myself to the front, but nevertheless, on account of the pleasant moments we have passed on the water with Prof. Molengraaff, I feel the need to speak and to give vent to the feelings dominating me at this moment. The first is one of great thankfulness to this distinguished Society, and especially to the President, for the delightful hours he has allowed me to pass amongst you. In the second place, I think you will acknowledge and admit the feeling of national pride that has come over me as being the representative of the country whose son we have heard reading this paper to-night. The great eloquence, with which Prof. Molengraaff has been able to explain to his distinguished audience with such clearness this paper, fills every Dutchman, and especially, I must say, the representative of Holland, with what I hope you will call legitimate pride. But in the third place, every medal has two sides, and the dark side is the knowledge of what an utterly ignorant person I am when I heard this learned man speaking about things I did not understand until I came here to-night. I must say we diplomatists (and I hope my distinguished friend Sir Walter Townley, who is here, won't reproach me for speaking in the plural) very often move in such a small circle that when we find ourselves confronted by men of science, as I have been to-night, we feel more helpless than ever. But you have put before me the great ambition to know more of these things, and I am sure a great many amongst the audience will share the feeling. If you make up your mind to see if Prof. Molengraaff was right in everything he said and want to convince yourself with your own eyes, do not go at once to the Colonies, but make a little stay in the mother country first. There is nothing which contributes so much to bringing two people nearer to each other than personal contact, and Holland and England, the Dutch and the British people, have so many things in common, they ought to be brought into nearer contact. Let that be one of the consequences of the delightful evening we owe to the Royal Geographical Society and Prof. Molengraaff, that many of you may go, in coming years, to Holland.

Sir WALTER TOWNLEY: As the President has just said, I suppose that the honour thrust upon me as I came into this room of expressing your thanks for the great interest of the lecture we have listened to, was due to the fact that I am the Chairman of the Council of the Anglo-Batavian Society which has been recently formed, the object of which is to further good relations between the Dutch and the English. You can imagine then that when I heard in the first opening utterances of the President a sort of hint that Prof. Molengraaff was going to sow the seed of further rivalry between the two peoples, who had been rather rivals for so many years, I received a slight shock, my object being the reverse. I listened, therefore, with the greatest interest to what Dr. Molengraaff had to say, and it was with considerable relief I weighed it up, and I made up my mind that at least what was to come was not going to come for centuries. Then I saw it was the rivalry of the old traveller in India, who felt as if the great mountain he had explored and loved so well was to have some of its glories taken from it. I think he need have no fear on that score. What he has done in the Himalayas will live for a long time, but that will be forgotten by the time these other mountains have grown up. We have learned

to-night a great deal, which has been most interesting, but I think something else also both from the paper of Dr. Molengraaff and from the speech of His Excellency the Netherlands Minister, and that is that people in Holland speak our language extremely well. Do you think there are many Englishmen who could get up and deliver a lecture like that without looking at his notes in good consecutive Dutch? There are very few. Is not that rather a good lesson for us? It has been my privilege to spend two and a half years in Holland, and nearly all the Dutch speak French, English, German and probably Italian as if these were their own languages. I should like our educational authorities to bear that in mind, and see if it is not possible to improve us a great deal in this direction. I should like to second the vote expressed by the Dutch Minister that the British and Dutch people get to know each other better. I came away from Holland with a determination that I would do what I could to further the bettering of good relations and good understanding between the Dutch and English. I do not wish to say any more except to ask you to allow me to express in your name our most grateful thanks to Dr. Molengraaff for his most admirable lecture, to which we have listened with so much interest.

The PRESIDENT: I am sure you would wish me to second what has been been said already by His Excellency the Netherlands Minister and Sir Walter Townley. We have listened to a most valuable and interesting lecture delivered in our own language with perfect fluency, and the Professor has put before us an extremely complicated subject in an exceedingly clear manner. We shall all wish to thank him for having taken the trouble to come over from Holland and for the way in which he delivered this lecture.

SOME OBSERVATIONS ON THE APPROACHES TO MOUNT EVEREST

Lieut.-Col. C. Howard Bury

DURING the summer of 1920 I was in India, on a mission from the Society, interviewing the various authorities concerned and trying to get permission for an expedition to Mount Everest. Unfortunately I was unable to get back in time to hear General Bruce's most interesting lecture on the various projected attempts to approach Mount Everest, and the discussion that took place afterwards.

As he pointed out, the chief and in fact the only obstacles that lay in the way of an approach to the mountain were political difficulties; there were questions that arose in different years between the Indian, Tibetan, Nepalese, Chinese, and Russian Governments, and these had to be settled first. At last, however, these difficulties have been smoothed away, and permission has been granted by the Indian and Tibetan Governments for an expedition to proceed to Mount Everest. There is thus every prospect that in the year 1921 the secrets that surround and veil the highest mountain in the world will be uncovered.

The mountain can be most easily approached from the northern side, and the road from Darjeeling to Phari over the Jelep La, and then viâ

Kampa Dzong and Tingri Dzong, would appear to present the fewest difficulties.

The direct road to Kampa Dzong viâ Gangtok and the Teesta valley, though it may be a day or two shorter, has many disadvantages. It is very little used by pack transport, and the path for several days follows the bed of the hot and feverish Teesta valley, where the rainfall is always heavy and where leeches abound. In places below and above Chungtang, where the path cut out of the solid rock overhangs the Teesta and Lachen rivers, there is hardly width sufficient for pack transport, and the loads would have to be taken off the mules and carried across these places. Whereas by going over the Jelep La the zone of the leeches and the heavy rainfall is soon crossed, and once in the Chumbi valley the climate is excellent, and there are no difficulties for pack transport. This is at present the main trade route into Tibet, and every day great numbers of mules and pack-ponies cross over the Jelep La, and in consequence grain and fodder can be obtained without any difficulty. From Phari to Kampa Dzong there are no obstacles; there is a regular trade route taking from three to four days and crossing over open and undulating country.

From information that I was able to obtain, the road from Kampa Dzong to Tingri Dzong presents no difficulties, and takes about seven days; from high ground north of the Naku La I could overlook several days' marches along this road, which appeared to follow along broad valleys about 15,000 feet above sea. There seemed to be no obstacles, or high passes which it would be necessary to cross.

Mount Everest I saw on several occasions in September, but always in the mornings or evenings. During the daytime heavy monsoon clouds would work up the Arun valley and into the side valleys, penetrating a certain distance into Tibet before they finally disappeared. From this it would appear that though Mount Everest lies out of reach of the main strength of the monsoon, yet clouds and snowstorms are frequent round its summit, especially in the afternoons. It lies, however, in a far better position with regard to weather than does Kangchenjunga, which seems to attract to itself all the heaviest storms.

I do not think that there are any advantages to be gained by making use of the lower Arun valley or of the Popti La and the Pangu La. Permission might be given by the Nepal Government, though they would not be enthusiastic about it. The paths through Nepal are bad and very fatiguing, and in the long run would prove to be no shorter, and would not be suited for pack transport. On the other route viâ Phari and Kampa Dzong pack transport of mules, ponies, or yaks can be used the whole way. There is a daily post to Phari, and letters only take three days from Darjeeling. There is also a telephone and telegraph line from Darjeeling to Gyantse, so that communication with the outer world can be kept up the whole time.

Aeroplanes would be of no use in Tibet, for though there would be

many places where it would be possible to land, yet owing to the density of the atmosphere at those heights being only half what it is at sea-level, it would be impossible for the present type of machine to rise again off the ground.

It would have been very interesting to have made a reconnaissance of the southern slopes of Mount Everest by flying up the Arun valley from the plains of India. This would have been probably feasible with a D.H.9a, but would have necessitated our providing at our own expense an aerodrome at the foot of the hills, the nearest permanent aerodromes being at Allahabad and Calcutta. The Air Force in India would have been very glad to help, but they have been limited in their own expenditure and would not have been able to devote any of their small budget to a side show, though they would be prepared to lend us a machine, pilot, and photographic apparatus.

The Air Force have had but little experience of flying in the hills, and the experiment would have been an interesting one for them. Where they have flown over hills, as on the North-West Frontier, they say that the air is full of bumps and air-pockets, necessitating their keeping their machines always at least 2000 feet above the level of the ground.

Beyond this reconnaissance from the south, I do not think that aeroplanes in Tibet could be of much use to the expedition: the general height of the country precluding any active co-operation on their part.

In Tibet ponies and yaks are the universal means of transport, and no one walks if he can help it, so that all the fatigues of long marches at high altitudes can be avoided by riding. The ponies are quite acclimatized to the height, and the European who comes into the country will find that after a fortnight's residence at 15,000 or 16,000 feet, he will be able to do far more and with less fatigue than when he first arrived. At greater heights than this the vitality becomes lower and sleep at night becomes more difficult, but acclimatization for Europeans is quite possible up to 16,000 feet.

Yaks will probably be the chief means of transport: they are very hardy animals, and seem to be able to live and to thrive on the scanty herbage that appears among the stones. They do not mind altitude, and though they are very slow yet they are surefooted, and it should be possible to use them for transport up to at least 20,000 feet. The snow-line on the north side of the Himalayas is often at 20,000 feet and over, and owing to the lesser denudation these northern slopes are far less steep than those on the south side, as can be seen on Pawhunri, Chomiomo, and Lhonak peaks, where in every case the south side is a series of precipices, and the north side is a comparatively gentle snow-slope. We may hope that this will also prove to be the case with Mount Everest.

The Sherpa Bhotias will probably prove to be the best coolies for high mountain work, and young men should be picked out for this particular duty. The Bhotia too from the high villages in Sikkim, such

as the Lachen villages, people who pasture their flocks at high altitudes on the Tibetan frontier, should also prove useful. They are both of a sturdy race of mountaineers, not so independent as the pure Tibetan, and should prove amenable to training. They have also the merit of being hardy and accustomed to cold and the biting winds of the country. They should be in charge of their own sirdars, and I am rather doubtful as to the advisability of having Gurkha N.C.O.'s over them. A good cook with the expedition is of great importance, as it is most necessary to keep the digestion in good order at these altitudes.

DR. KELLAS' EXPEDITION TO KAMET

IN the course of General Bruce's paper on Mount Everest, published last month, it was announced that Dr. Kellas and Major Morshead had succeeded last autumn in reaching the saddle of Kamet (at 23,500 feet), but that transport difficulties had prevented the formation of a camp at that height, or any further advance.

Dr. Kellas had planned the ascent of Kamet with special reference to the physiological effects at high altitudes and the use of oxygen. The Oxygen Research Committee and the Medical Research Committee, under the authority of the Department of Scientific and Industrial Research, undertook to supply the necessary scientific equipment, which was forwarded by the Indian Stores Department to Kathgodam. Dr. Kellas had left for India in March, and the equipment had to be got together and forwarded to him. Some unavoidable delay occurred owing to the discovery that the very light oxygen cylinders, which passed their tests when newly made, lost strength rapidly and were not safe. It was therefore necessary to send heavier cylinders. Further delay was caused in the transport to India by certain shipping restrictions in the carriage of gas cylinders and chemicals; and finally there was some unexplained delay on the Indian railways, so that the start of the expedition from Kathgodam was considerably late, and to this one must attribute any want of complete success in the investigation. The preparations of the Oxygen Research Committee were made under the disadvantage that owing to ill health Dr. Kellas had been unable to attend to them in the preceding winter, and had to leave instructions for execution after his start. The Society must gratefully acknowledge the value of the contribution to the Mount Everest problem thus made by the Committee in difficult conditions.

Dr. Kellas, who has remained in India with the intention of making another attempt on Kamet next summer, has sent us a copy of the report he has made to the Oxygen Research Committee; and in view of its immediate importance to the Mount Everest expedition, we assume his permission to print the following extracts from it:

At the end of the first week in August part of the expedition started from Kathgodam, and on August 19 joined Major Morshead at Chomoli, about 150 miles to the north. The permanent members of the expedition included Major Morshead and his transport officer, with eleven attendants—the latter being intended chiefly for survey work, and also for transport at high altitudes—and myself with two servants. There were about eighty-three coolie loads.

From Joshimath, 29 miles north of Chomoli, transport work was difficult, and repeated unvoidable delays occurred. Four bridges had been washed away in the Niti valley by floods, but the Deputy Commissioner of Garwhal, Mr. P. Mason, made such arrangements that we had only to build one bridge over the river Dhauli.

On August 29 we started from Niti, the highest village on the route (12,000 feet approx.), with about twenty-one yaks and forty coolies (each yak carrying two coolie loads), and on August 31 reached a base camp at the end of the Raikana glacier at an altitude of 15,380 feet.

Above this point the route was very rough, and all baggage had to be carried by coolies. Carriage of wood, which could be obtained about a mile below the camp, became of special importance. Even at this base camp (No. 1) want of acclimatization to altitude began to be evident in certain cases, and incidence of malaria was also troublesome.

On September 3 an advance was made along the east Kamet glacier—which was found to be quite incorrectly given on the map—and a camp formed at about 16,800 feet. This camp was on fine sandy detritus on a bank above the glacier, and was generally regarded by the coolies as the last comfortable camp. A delay occurred here due to difficulties in connection with transport of wood, and it was September 8 before Camp No. 3 was formed at 18,500 feet on rough glacial detritus above ice. This third camp was near the base of Kamet, which rose in a series of rock precipices to the north-west, forming a comparatively sharp peak. Between this peak and the ridge of east Ibi Gamin (24,170 feet), to the north-east there was a snowy saddle of altitude about 23,500 feet, which obviously indicated the route to the summit. The increase of height between this third camp and the saddle—namely, 5000 feet—consisted firstly of 2500 feet of sharp ascent, chiefly steep scree, but partly débris-covered glacier, then came 1000 feet of precipitous rock, and finally about 1700 feet of snow and ice. From the configuration of the mountain it seemed likely that the tops of these three "pitches" would necessarily represent positions for camps 4, 5, and 6. At this third camp my chief servant became so incapacitated—he had been accidentally benighted on the glacier along with Major Morshead's servant—that he had to be sent back to Niti.

On September 11 we moved up to a camp above the screes—camp No. 4—our tents being pitched at 21,000 feet (approx.). Here the transport was unsatisfactory, and we were detained about a week. At this camp it became evident that our remaining servants would be unable to go higher. Both seemed to have reached the limit of their acclimatization powers, in spite of being adequately protected, and suffered from the cold—approx. 0° Fahr. during the night—while my servant again had attacks of malaria.

On September 19 we climbed the rocks, and formed a camp on snow at approximately 22,000 feet. After a day at this camp to allow acclimatization to take place, we ascended to a little above the saddle along with three coolies from the village of Mana, starting at 9 a.m. and reaching the saddle at 3 o'clock. At 3.30 we had attained about 23,600 feet, our maximum altitude,

but the coolies declined to attempt Ibi Gamin (24,170 feet), which seemed feasible, or to ascend further on Kamet. Starting back at 3.45 p.m. (approx.) we descended rapidly, and reached our 22,000-feet camp about 5 p.m. The wind was cold, and the three coolies with us suffered more than Major Morshead or myself, and complained of headache. A considerable amount of step-cutting was necessary, which was shared.

Next morning Major Morshead unfortunately had to descend, as his period of leave had expired, taking all the coolies with him. The coolies refused to entertain the idea of moving a camp up to the saddle, alleging that the winter storm was due, and that we would be snowed up. The threatened incidence of this winter storm had been their continual complaint since reaching Camp No. 3, but otherwise the men from Mana village (10,000 feet), some of whom were coolies who had been with me previously in 1911 and 1914, behaved very well, and indeed were the mainstay of all the hard work carried out. On three occasions at Camp No. 4 we had about a couple of inches of fresh snow, the bulk of which quickly evaporated.

At the base camp I tried to get coolies to come and pitch a camp on a pass between the Raikana glacier and the Ganeshganga valley to the north, from which one could carry out experiments with the oxygen cylinders and Prof. Hill's rubber bag on a beautiful snow-peak 21,700 feet high, which evidently could be climbed. Even a heavy snowstorm could have been weathered in such a position, but the coolies refused to obey the transport officer, and would not even transport wood a distance of 3 miles to a base camp below the Ganeshganga peak mentioned. In addition to this, when on two consecutive days the yakmen had driven off their yaks unloaded, and men had to be sent after them to bring them back, it was evident a retreat was necessary.

We therefore made a double march to Niti on October 1, and on the following day reached Malari, a large village about 10 miles to the south. I had not agreed to the retreat from the Raikana glacier until the transport officer had promised to try and make an arrangement at Malari to visit the Bagini glacier to the south-east, and form a high camp on a suitable mountain for carrying out experiments, and I had fixed upon Dunagiri Peak (23,184 feet), the finest mountain of that region, for the purpose.

On October 3 we moved south from Malari, and on the 5th reached Dunagiri village (11,150 feet), about three days' march from the mountain of the same name. It soon became evident, however, that the Dunagiri men were somewhat inefficient coolies and knew nothing of snow work, so that the idea of forming a camp at 20,500 feet on Dunagiri was abandoned, and a camp formed at 18,000 feet on a more accessible mountain about 21,000 feet high to the north-west of the Bagini glacier.

About a week's work was carried out at this high camp, and Dunagiri was regained on October 16. From there continuous travel *viâ* Joshimath, Karuprayag, and Ranikhet brought us to Kathgodam on the 5th, and thence to near Darjeeling on November 9, after an absence of four and a half months.

I. *Experiments with Cylinders of Compressed Oxygen.*

On testing the weight of the oxygen cylinders at Kathgodam it became evident that they were almost certainly too heavy for high altitude work.*

* They are nearly three times the weight of the cylinders previously shown to me, and had I known that these alone were available I would have cut down the number requisitioned from seventy-two to twenty-four. I quite recognize, however, that everything was done that was possible in the circumstances.

Their weight (16 lbs. approx., or with pressure regulator, etc., nearly 20 lbs.) is as much as most coolies care to carry as a load even at 20,000 feet. Preliminary experiments at 21,000 feet on Kamet confirmed that they were unsuitable, but no opportunity of working out systematic experiments occurred until after reaching the camp at 18,000 feet, near the Bagini glacier.

Experiments were carried out over three different courses: (1) a long course involving an easy snow ascent of 3000 feet (approx.) and return; (2) a medium course involving an ascent of 600 feet over rough snow, and return by a rock scree; and (3) a short ascent along a stony arête of about 200 feet.

In a typical experiment over the long course coolies took 2½ hours without oxygen cylinders, and 3 hours 40 minutes using oxygen cylinders, the use of oxygen being stopped at the summit.

Most of the experiments were carried out on the medium course, and the results were consistent. In one typical case 39 minutes were required with an oxygen cylinder, and 28 minutes without it, and a different man took 43 minutes with a cylinder and 30 minutes without.

On the short course typical results were 8 min. 20 sec. without cylinder, and 10 min. 30 sec. with it; and 8 min. 20 sec. without, and 11 min. 20 sec. when using one.

The conclusion from above results must obviously be that the cylinders are too heavy for use above 18,000 feet, and below that altitude they are not required. They would be quite useless during an attempt on Mount Everest.

It would seem advisable in the circumstances to carry out experiments with cylinders of double the capacity filled to half the pressure, so that a light cylinder similar to that shown to me in 1919 by Colonel Stewart could be safely employed. A volume of 140 litres (*i.e.* 5 cubic feet) of oxygen might be helpful, if the weight of the cylinder were not above, say, 7 lbs.

II. *Prof. Leonard Hill's Rubber Bag and Oxylith.*

Two sets of experiments were carried out. In the first set the subjects breathed oxygen from a freshly filled bag containing strong solution of caustic soda for about five minutes, shaking the bag from time to time to promote absorption of carbon dioxide. They then immediately started up the short course mentioned above—the stony arête—and returned to the starting point, the time required being noted. After about fifteen minutes a repeat experiment was carried out without breathing from the bag.

As a rule the times were practically identical, so that it seemed that no benefit accrued from breathing oxygen while resting, and that the excess amount in the lungs at starting was of negligible value in promoting ascent.

Such a result might be expected from theoretical considerations. In the experiments of the Anglo-American Expedition on Pike's Peak (14,100 feet), it was found that about 345 c.c. of oxygen * per minute was required by the body when standing erect, and that nearly six times as much (1940 c.c.) was required when ascending a gradient of 1 in 4. The healthy body at rest would therefore probably have little difficulty in providing itself at 18,000 feet—and probably even up to 30,000 feet—with the necessary oxygen; but it is obvious that the great increase required immediately an ascent is started would be practically uninfluenced by any small residue of oxygen in the lungs.

* This is substantially the same as the values found by Haldane and by Zuntz for near sea-level.

The second set of experiments were carried out while breathing continuously from the freshly filled bag during the ascent. The apparatus was carried under the arm, which was inconvenient.

In this case the gain while using oxygen was quite decisive, the advantage being up to 25 per cent. This again was to be expected, and clearly indicates that the light oxygen cylinders suggested above might be of considerable value as regards increase of rate of ascent at high altitudes. It is also evident that if such light cylinders cannot be obtained a modified form of Hill's bag, of considerably increased capacity—say, 150 to 200 litres—might be of use. Such a bag should preferably be made so as to tie on the back, the mouthpiece being brought over the left shoulder. The absorption of the carbon dioxide by caustic soda should be adequately arranged for.

It might therefore be recommended that bags of the type indicated above should be tested next year on the expedition to Kamet. Only two such bags would be required.

III. *Observations on Mountain Sickness.*

Contrary to the author's observations in previous expeditions, mountain sickness, in one form or another, was not uncommon. Two reasons explain the difference. In the first place, in previous expeditions picked hillmen were employed, whereas in this case several men from near the plains were present; and in the second place, most of the coolies in preceding expeditions were Buddhists, who can vary their diet, whereas on this occasion the men were Hindoos, and handicapped by a comparatively rigid diet which in some respects is unsuitable for high altitudes, unless under special conditions, difficult to arrange for. As it is extremely difficult to cook the nitrogenous vegetable foodstuffs above 16,000 feet, fresh mutton should be supplied.

IV. *Acclimatization to High Altitudes.*

Satisfactory acclimatization to the maximum altitude reached was attained by only two members of the expedition, namely, Major Morshead and myself. This is probably in some measure well shown by pulse and respiration rates, which were always taken at rest while sitting.

The time spent at the highest camp (22,000 feet), however, two and three nights respectively, was insufficient to arrive at definite conclusions as to the completeness of our adaptation to that altitude. In connection with the projected ascent of Mount Everest (29,141 feet), it is obvious also that capacity for acclimatization should be tested at higher altitudes, and next year the author hopes that it may be possible to camp for a week just below the Kamet saddle, at an elevation of about 23,400 feet.

A few cases of Cheyne–Stokes breathing were observed, although as a rule at least twenty-four hours were allowed for acclimatization to take place before making observations.

V. *Suitable Diet for High Altitudes.*

In previous expeditions it had been observed that a depreciation of appetite seemed to occur after residence for some time above 20,000 feet. As it was possible that this might have been due to the diet, which had consisted entirely of tinned foods, chiefly cold because of difficulties regarding fuel transport, an attempt was made on this occasion to get an approximation to the diet usually taken at sea-level as already mentioned. Fresh mutton and

vegetables were used at the higher camps, and the food varied as much as possible. The effect was distinctly good, and no diminution of appetite was observed, even at the 22,000-feet camp; but, as already indicated, the time spent there was too short to form a definite opinion as regards completeness of acclimatization.

During the ascent to the saddle our appetites seemed good, but we had little time for halts, because of the amount of step-cutting necessary, and there was also a very cold wind. As liquid refreshment, we had a large Thermos flask filled with hot Bovril.

As a rule when camped on snow the fuel used is petroleum or methylated spirit, generally the latter, and in conection with the proposed ascent of Mount Everest we wished to find out whether a Primus lamp could be used above 21,000 feet. We had two Primus stoves with us of somewhat different constructions, and both worked well at 18,500 feet. At 21,000 feet the better of the two was fairly satisfactory, but at 22,000 feet we could not get it to work at all, and had to fall back upon a lamp burning methylated spirit. Next year, by employing flat slabs of stone as hearth, it might be possible to utilize wood at the camps on snow.

VI. *Experiments with Major Flack's Mercury Manometer to test any Variation of Strength and Energy with Increase of Altitude.*

Major Flack's apparatus can be so easily employed, that it was intended to carry out experiments with it even on the summit (25,447). The difficulties regarding transport already detailed, however, prevented results being obtained above 21,000 feet.

Observations showed that the expiratory force does not seem to vary at all with altitude up to 21,000 feet, but, as was to be expected, the capacity for sustaining a 40-mm. column of mercury rapidly diminishes as one ascends. The times during which the breath can be held at different altitudes were also taken: they should probably be approximately comparable with those for the 40-mm. column. The nose was held or clipped during the latter experiments, a procedure which experience shows to be absolutely necessary.

The results show clearly that the expiratory force is about the same at 21,000 feet as at 1600 feet. As a large proportion of the trunk muscles are involved in the expiratory effort, their tone and capacity for exerting force for a short period is apparently unaltered, and therefore probably the same is true for all the muscles of the body. If, when at high altitudes, however, one tries to keep the column of mercury at its maximum height, fatigue appears to supervene much more quickly than at sea-level, presumably because the oxygen supply to the muscles and brain is less; there is, however, a fairly rapid recovery.

One would not, of course, expect the time of maintenance of the 40-mm. column or the time of holding the breath to be the same at different altitudes, and the Table of Results showed a rapid diminution of capacity in both cases. One might reasonably suppose that the normal times in each case would be approximately proportional to the alveolar oxygen pressures, but the time of support of the 40-mm. column would be less than that of holding the breath for various reasons, perhaps more especially because the muscles in action would be using more oxygen, and the oxygen of the "dead space" would have less chance of being utilised.

SUMMARY OF VARIATION OF ALVEOLAR OXYGEN PRESSURE AND TIMES OF HOLDING THE BREATH WITH ALTITUDE.

Place.	Altitude. Feet.	Calculated normal alveolar * oxygen pressures, mm. of mercury.	Times of holding the breath in seconds. Morshead.	Kellas.	Sobhan Singh.
Kathgodam	1,600	95·5	—	82, 85, 93	—
Chomoli	3,620	87·5	50	—	—
Juma Gwar	8,250	71·0	60	67	50
Raikana Glacier ...	15,380	50·7	31	46½	26
Camp No. 3	18,500	43·2	25	42	25
Camp No. 4	21,000	37·9	—	33	23

VII. *Rate of Ascent.*

The times of holding the breath, and the alveolar oxygen pressures at different altitudes, are obviously connected with the possible rates of climbing, and it could be shown that, assuming 1000 feet change of altitude per hour on easy ground to be an average rate of ascent at the summit of Mont Blanc (15,780 feet), the rate at 23,000 feet would be about 600 feet per hour. On this occasion, excluding halts, our speed was only a little above half that value, viz. 320 feet per hour, but, considering the amount of step-cutting necessary, this was about what would have been expected. On previous expeditions the author has found that his rate of ascent on easy snow at 23,000 feet approximated to 600 feet per hour, agreeing with Longstaff's experience on Trisul. On such a basis, the calculated rate of ascent for the last 1000 feet of Mount Everest would be between 250 and 350 feet per hour. Possible rates of ascent may be further tested and elaborated in next year's report.

VIII. *Variation of Minimum Temperature with Altitude.*

Raikana Glacier.

Base Camp No. 1	15,380 feet	31–8–20	Min. 30° Fahr.	
2nd Camp	16,800 ,,	4–9–20	,, 23° ,,	
3rd ,, ...	18,500 ,,	9–9–20	,, 15° ,,	
4th ,, ...	21,000 ,,	12–9–20	,, 4° ,,	
5th ,, ...	22,000 ,,	19–0–20	,, −15° ,,	

THE DEATH OF MUNGO PARK

WE are indebted to Viscount Milner, Secretary of State for the Colonies, for the communication of the following despatch from Sir Hugh Clifford, Governor of Nigeria :—

Government House, Nigeria,
3 May 1920.

MY LORD,

I have the honour to bring to your notice some interesting facts which appear to fix with reasonable certainty the date of the death of the explorer, Mungo Park, at Boussa. I enclose a note on the circumstances of Park's death in so far as they are recorded in the published account of his travels. From this it will be seen that the last recorded date in his journey down the Niger is the 19th November 1805, on which day he left Sansanding. The fact that he afterwards met his death at Boussa is established by the narrative of Amadi Fatouma and confirmed by native tradition. The story

* Calculated from Miss M. P. Fitzgerald's values, *Phil. Trans. B.*, 5, 203, p. 359.

as it is told at Boussa is mentioned in a letter from Resident Kontagora, a copy of which is enclosed herewith. From this it appears that an eclipse of the sun took place on the morning after Park died. I am informed by the Acting Chief Surveyor, Northern Provinces (Mr. T. J. Waters), that a partial eclipse of the sun was probably visible at Boussa in the early morning of 16 June 1806. That would allow about seven months between Park's departure from Sansanding and his death at Boussa. A total eclipse of the sun was also visible at Boussa on the 29th November 1807, but it is unlikely that the journey down the Niger from Sansanding to Boussa occupied as much as two years. Nor do I think that any importance need be attached to the statement that the Ex-Alkali of Yelwa was alive at the time of Park's death. Natives of an advanced age are notoriously slipshod in their reminiscences. Obviously, too, Park could not have been alive in 1833. On the whole, therefore, there seem to be reasonably good grounds for supposing that the death of Mungo Park took place on the 15th June 1806, *i.e.* on the day before the partial eclipse mentioned above.

2. The "coin" mentioned by the Resident Kontagora is a silver medal of George III. which has been converted locally into a ring. It is still prized among the insignia of the Emirs of Boussa.

3. I have brought these facts to Your Lordship's notice in the belief that they will be of interest to the Royal Geographical Society as well as to Mungo Park's descendants, if any exist.

I have the honour to be,
Your Lordship's most obedient humble servant,
(Signed) HUGH CLIFFORD,
Governor.

The Right Honourable Viscount Milner, P.C., G.C.B., G.C.M.G.,
Secretary of State for the Colonies.

Enclosure.

The Provincial Office, Kontagora,
25 July 1919.

SIR,

In continuation of my minute (6) of 17 July 1919, M.P. 1818/1919, the following is an extract from a report by Mr. J. C. O. Clarke, dated 24th March 1913: "When Kisaran Dogo was 'King' of Boussa, a white man came down the Niger in a canoe. He gave Kisaran Dogo a large coin. When Neda his daughter was about to marry he had the coin attached to a ring as a wedding gift for Neda. Neda did not accept the present, stating that she preferred slaves, which were given to her. Kisaran Dogo kept the ring, which has been worn by every Sark in Boussa since that time. The white man (Mungo Park?) stayed a few days at Boussa and then started down the Niger; the same day his canoe was capsized in the rapids of Bubarro between Malali and Garafini. It is said that when the next day broke night immediately came on again. Ex-Alkali Lowal of Yelwa was at that time eight years old, so this would be 70 or 80 years ago."

2. The marginal note points to a total eclipse of the sun, which might be useful in establishing the exact date of the death of the explorer.

I have the honour to be, Sir,
Your obedient servant,
(Signed) W. HAMILTON-BROWNE,
Resident Kontagora.

The Secretary, Northern Provinces, Kaduna.

According to the 'Journal of a Mission to the Interior of Africa in the Year 1805,' by Mungo Park, published by John Murray in 1815, Park with Lieut. Martyn and three soldiers left Sansanding on the 19th November 1805, and continued their voyage down the Niger under the guidance of Amadi Fatouma. Park's Journal was sent back from Sansanding by Isaaco, who in 1810 was engaged by the then Governor of Senegal to return in search of news. Isaaco's journal embodied the story told by Amadi Fatouma (pp. 211 to 215 of the above work), but it is not possible to form from this account any precise idea of the date when Mungo Park was drowned in the rapids of Bubarro.

Dr. A. C. D. Crommelin, of the Royal Observatory, Greenwich, has very kindly examined the circumstances of the solar eclipses visible on the Niger in the early years of the nineteenth century. He writes: "I do not think either of the eclipses fits the native report well. That of 16 June 1806 was large at Bussa, but it occurred just before sunset, not just after sunrise. That of 29 November 1807 was total at or very near Bussa, but totality occurred at noon, with the sun 58° high. Perhaps we may allow something for the vagueness of native tradition. There was a fairly large eclipse soon after sunrise on 17 August 1803, but that is inadmissibly early. On the whole, I think a thunderstorm is the best explanation, and the 1807 eclipse the next best; the 1806 one is definitely excluded."

Dr. Crommelin's report was communicated to the Colonial Office, and thence to the Governor of Nigeria, who replied as follows:

Government House, Nigeria.

MY LORD,

With reference to the request contained in the final paragraph of the letter from the Secretary of the Royal Geographical Society, enclosed in your Lordship's despatch No. 940 of the 28th June 1920, I have the honour to say that I have caused further inquiries to be made, and I fear that no information is likely to be obtained from native tradition which might enable the date of Mungo Park's death to be fixed with certainty. It is extremely probable that the facts of the total eclipse of 1807 and the death of Park in 1806 have become connected by legend, and the eclipse which really happened the next year may easily after such a lapse of time have come to be spoken of as having happened the next day.

I have the honour to be,
Your lordship's most obedient humble servant,
(Signed) HUGH CLIFFORD,
Governor.

The Right Honourable Viscount Milner, P.C., G.C.B., G.C.M.G.,
Secretary of State for the Colonies.

It appears therefore that the promised clue has led to nothing definite, and that the precise date of the death of Mungo Park will remain unknown.

MAP PROJECTIONS

Some Investigations into the Theory of Map Projections.— Alfred Ernest Young. R.G.S. Technical Series, No. 1. London: R.G.S., Kensington Gore, S.W. 7. *Price* 6*s. net.* To Fellows 5*s. net.* vii. + 76.

THIS book of seventy-six pages, some of which are very condensed, is the most important contribution to the subject of map projections that has appeared in English for many long years; and it is especially to be welcomed as it is the first of a projected series of publications to be issued by the Society, the series being "designed to include important contributions to geography too technical and too long for the *Geographical Journal*." The series begins remarkably well, and, if it continues as it has begun, the Society will be able to congratulate itself on assisting in the production of important additions to knowledge.

The writer, Mr. A. E. Young, is well known as a mathematician who has devoted himself to the study of technical survey problems. He was for many years in charge of the trigonometrical and scientific side of the work of the Survey Department of the Federated Malay States. Mr. Young describes, in the preface, how he was led to investigate the theory of map projections by being asked by Mr. Hinks to compute some tables required for the new map of Africa on the scale of one to two million. This happy chance has resulted in investigations of a really important and original nature.

The main purpose of the book is the investigation of a greatly extended application of Airy's principle of Balance of Errors. It is, of course, well known to map-makers that Airy's principle aims at the construction of a projection that shall represent neither areas nor small outlines correctly, but shall be, as it were, a sort of golden mean. We must imagine that at every point on a map there are always two errors of scale to be considered, in two directions at right angles to each other, usually, for convenience, the two directions are chosen along a system of great circles and at right angles to them. Roughly speaking, Airy's method is to make the average scale error a minimum over the portion of the sphere represented. The principle has much to recommend it, but the objection may be urged against it that it does not make the *largest* scale error a minimum.

Airy applied the principle to the "zenithal" class of projections; Mr. Young has successfully applied it to the general conical class, of which the zenithal is only a particular case. Moreover, Mr. Young has been able to apply the minimum-error principle to zenithal projections of which the form has already been determined, such as the zenithal orthomorphic and zenithal equal-area projections. This latter process may be looked at somewhat in this way: Suppose that we have calculated a zenithal equal-area projection and plotted it on paper and drawn a scale on the same paper; the scale so drawn will be in terms of the radius of the Earth equal to unity, where unity is some definite length on paper. Everything is now fixed, and if we still keep the radius equal to unity, however we may enlarge or reduce the map and scale together, the projection remains the same. Or, in other words, so long as we keep the scale at the "centre" of the map true we have no means of improving the projection. But suppose that we alter the scale at the centre; this is the equivalent of leaving the projection as it is but *redrawing the scale.* If we allow ourselves this freedom we can choose that scale which, given the condition of equivalence, shall result in the smallest average linear

scale error. This is what Mr. Young does, and we are immediately introduced to the zenithal equal-area minimum error projection, and similarly to the zenithal orthomorphic minimum error projection, and the zenithal equi-radial minimum error projection. Clarke had already given us the minimum error perspective projection. Dealing with this group of projections, the writer makes the remark that it may appear more natural to find the average error by integrating over the surface of the map rather than over the corresponding surface of the Earth, an idea which is probably valid, and has no doubt occurred to many who have studied Airy's Projection. He then shows what small differences may be expected in the resulting projection.

The author next deals with the more general problem of the application of the minimum-error principle to conical projections, and this is the longest, and perhaps the most interesting, portion of the book. In a conical projection the parallels are incomplete portions of concentric circles and the meridians are their radii. It is required to find the values of these radii for the different parallels, given a particular "constant" of the cone, the constant of the cone being the proportion which the angle between any two given meridians bears to the true difference of longitude. If we can dispose of the value of the constant of the cone, we have another degree of freedom. After a discussion of the general formulæ, the author gives a numerical example (on the spherical assumption), which may be quoted as giving us an idea of the kind of error involved. Taking a map extending from the equator to latitude 60°, a minimum-error conical projection, by balance of errors, will have a maximum scale error on the upper parallel of +12·5 per cent., +8·7 per cent. on the lower parallel, and −4·5 per cent. on the mid-parallel.

The reviewer is inclined to think, without in any way minimizing the great theoretical value of Mr. Young's investigations, that the practical map-maker may be well advised to consider, not the average scale error, but the maximum scale error. It appears, indeed, in the general case, not unfair to judge of a projection by its maximum scale error.

But Mr. Young has not entirely neglected practical considerations. He points out, for instance, how the errors of our old friend the Cassini projection can be lessened by reducing the scale error along the principal meridian by one-third of the scale error at the extreme east or west of the map, thereby making the average linear error a minimum ; a kind of device already used in the projection for the International Map. Space does not allow of an adequate account of this section of his work, which is full of good things, notably the re-establishment of the value of Murdoch's two projections, (A.D. 1758), which were treated with less than justice by Germain.

An important contribution to the study of projections is the investigation (which extends to some eight pages) of the spheroidal formulæ for the conical orthomorphic projection with two standard parallels. Those who are acquainted with the technical work of the survey battalions on the Western Front will remember that it soon became evident that orthomorphism was a useful quality in a military map. Steps were, in fact, being taken, when the Armistice was signed, to convert our maps, which depended upon the Belgian Bonne projection, into orthomorphic terms. Mr. Young has now given us the full formulæ for the spheroid, and they will be found of real value. A mental note should be made by all interested in military maps that the investigation of the formulæ of this useful projection is to be found in the work under review.

To sum up the impressions derived from an attentive perusal of Mr. Young's paper—we have in these investigations a series of original studies which must

in future be read by all interested in the subject of map projections. Most of them are concerned with the principle of smallest average error, and Mr. Young has greatly extended the application of this principle. He has also been the first to point out the radical importance of the proper use of the "scale constant"; he has given us a full examination of the spheroidal formulæ for the conical orthomorphic with two standard parallels, and has re-established Murdoch's reputation. C. F. C.

THE WESTERN SAHARA

Société de Géographie.— Captaine Augiéras. Le Sahara Occidental. Paris: Masson et Cie. 1919. Pp. 48. *Map.*

IN this brochure Captain Augiéras sets forth, with great lucidity, the knowledge gained by French officers in the Western Sahara since the opening of the twentieth century. Among these officers the most notable are Captain Flye-Sainte-Marie, General Laperrine, Captain Martin (who died of thirst in the desert, the fate which through an aeroplane accident subsequently befell General Laperrine), and Captain Mougin. These and a few other officers have given us all the exact knowledge we possess of that part of the great desert.

The reader, however, soon discovers that the author uses the term "Western Sahara" in a restricted and somewhat arbitrary sense. He excludes the whole of the coast region, Mauritania, and the area around Timbuktu, while including part of the Moroccan Sahara. On the east the limit adopted is the wadi Saura-Messaud and the Tanezruft south of that wadi.

Within the limits indicated the Western Sahara covers some 386,000 square miles, being nearly double the size of France. Much of it still remains unexplored, but its general characteristics are now clear. In the centre is a crystalline plateau of moderate elevation, "the eruptive zone of the Eglabs, which may be said to form the dome of the country." This "dome" (no indication of its height is given) is surrounded by a lower region in great part covered with sand-dunes—the Juf on the south, the Erg Igidi to the west and north, the Erg Shesh to the east. Rocky plateaus rise north-west of the Igidi, to the north-east a series of parallel folded ridges (Hercynian) separate the Igidi from the valley of the Saura. Farther north the last bastions of the Atlas mark the end of the desert. And in the Western Sahara desert conditions are much accentuated, oases scarcely exist save upon its periphery. It is without inhabitants; "one may travel in it for months without meeting a single human being." Large areas, including much of the central "dome," are indeed devoid of any kind of life, either animal or vegetable. But in general the Ergs, the hills, and the hammadas have both flora and fauna; some of the hammadas are even "relatively alive. One likes to pitch one's tent there." The date-palm grows in the Ergs, the "talha" (*Acacia tortilis*) in the jebels and hammadas, in some places even forming the semblance of a wood. In the wadis the tamarisk (*T. articulata*) is found. There are several small shrubs and plants, one of the latter with a pretty violet-coloured flower. The chief animals are antelope and moufflon. The leopard is occasionally seen; reptiles and insects are numerous. There is a fly whose bite is sometimes fatal to camels. Captain Augiéras states that the temperature is "particularly high" because the Western Sahara is a depressed region, in which the dunes

rapidly absorb an enormous quantity of heat, which is given out with equal rapidity. Hot as is the air, the soil is still hotter, and one cannot walk barefooted without getting badly burned. Winter temperature appears to be about 25° lower than the summer, and on two or three nights in the year there may be frost. Rain falls perhaps once a year; dry tornados, with the sky opaque for days together, occur in the summer.

Although now uninhabited, the Western Sahara still contains habitable tracts. All the evidence goes to show, however, that it is becoming increasingly arid. There is the skeleton of the old river system, concerning which Captain Augiéras confirms the conclusions of other observers already recorded in the *Journal*. The "innumerable indications" of former habitation are almost all pre-Islamic, but there are traces of baked mud houses certainly not more than two hundred years old. Tradition has it (though this is not mentioned by the author) that there were settlements in this part of the Sahara up to a much more recent date. There are routes across the desert between the Niger and Morocco along which water can be obtained, and for many centuries the country was traversed by large trading caravans to and from Timbuktu. It was with one such caravan that René Caillié made the journey to Tafilet in 1822. In that caravan were some 1400 camels, and the journey lasted seventy-five days.

How long after Caillié's journey this route was used the present writer has not been able to ascertain; it would be of interest to know. The only other complete traverse of the Western Sahara between Morocco and the Niger was made by Oskar Lenz in 1880. Unfortunately neither Caillié nor Lenz was able to give any detailed geographical data, and presumably we shall have to wait for the complete pacification of Southern Morocco before a thorough scientific investigation of the Western Sahara is possible.

For such work as French officers have been able to do in the last twenty years has been only what inclination prompted and militaty duties permitted. It might be supposed that there was no call for military work in an uninhabited region—where not even the nomads who live on its borders take their herds to graze. But the country is still used as a highway by Moroccan bandits, who make annual raids on the Sudanese tribes in the Timbuktu region and the Berber tribes of the Adrar of the Iforas, to protect whom the French have organized a special service. It is one of the ironies of the pacification of North-West Africa by the French that it put a stop to the last of the trading caravans which used the Western Sahara—that from South Morocco to Tuat, though Captain Augiéras looks forward to the time when with the occupation of Tafilet trade will revive.

Meantime the bandits lead a merry life. Their knowledge of the country, their endurance, the suddenness of their descent on unsuspecting tribes, puts all the trumps in their hands. And they have no sense of shame—they fly at once if they think they are the weaker party. The Meharists may go in hot pursuit, keeping up the chase for hundreds of kilometres, but "often without result." The bandits moreover, if pressed, resort to an excellent stratagem—they disperse in small parties in the immensity of the desert. "In which case the troop in pursuit has nothing to do but to stop—and keep rigorous guard during the night." All the raids are made from Morocco to the Sudan—there are no known itineraries between Mauritania and Tuat.

Captain Augiéras devotes the second part of his paper to a detailed account of the construction of the map. Every care has been taken, and the map itself (1/500,000) is the best we have of the Western Sahara, though its author,

who has now for seven years been exploring the country, speaks of it modestly as but a first approximation to exactitude. But, as he adds, it gives a general idea of the region, the distances to be covered, and the difficulties to be encountered. It still has many blanks—the Juf, the Tanezruft, and other regions remain unknown. Africa has not yet yielded up all her secrets.

FRANK R. CANA.

REVIEWS

EUROPE

The Russian Almanac, 1919.— Compiled and edited by **N. Peacock.** Pp. 209. Published for the Anglo-Russian Trust by Eyre & Spottiswood London. *Price 5s. net.*

PUBLICATION of the Russian Year-Book was suspended in 1917, and now Miss Peacock, its editor, has undertaken the difficult task of compiling a work of reference on Russia as it is to-day. The volume includes some survey of Finland and Siberia, as well as all the European territories which formed part of the late Russian Empire. Russian statistics were never noted for trustworthiness, and now they are practically unobtainable. In many cases figures of the past era in Russia are given for want of more recent information. Making allowances for these difficulties, we have found the information accurate and useful. A short list of books on Russia might be amplified by a note on maps. The addition of a few maps would enhance the value of this volume. The lack of an index is a serious omission. R. B.

ASIA

Annals and Antiquities of Rajasthan.— **Lieut.-Colonel James Tod.** Edited with Introduction and Notes by **W. Crooke, C.I.E.** In 3 vols. Oxford: University Press. 1920. *£2 12s. 6d. net.*

On its first appearance this well-known work was noted by a sympathetic reviewer as standing out, in form and matter, from its contemporaries "in an age of duodecimos." Glancing from the lordly quarto which has delighted several generations of students of Indian life to the handy octavo in which it is here presented, the comparison suggests itself between the opportunities afforded by the spacious times of the author's service in India and those which now fall to the lot of his more migratory official successors of to-day. Tod was in India from 1798 to 1822, without a single day's leave, and all but the first seven years were passed in the tract of which he writes. It was in a state of anarchy and transition, and for the greater part of his sojourn there his life was "a tissue of toil and accident." Nevertheless, his intensive study of the region and its peoples was unflagging. He was steeped in grain in the traditions, customs, and balladry of the chivalrous and romantic communities of whose interests he was in charge, so that "wherever his eye fell, it filled his mind with images of the past." His great work is not, of course, without shortcomings, of which some must be ascribed to the author himself, but more to the time in which he lived, when the systematic study of ethnology, epigraphy, and social life generally was in its infancy. Taking the Annals as a whole, however, it may be said of them, as has been said of Macaulay's two Indian Essays, that inaccuracy in facts is apt to be taken as venial in the enjoyment of their literary charm.

The work, then, is well worth the tribute of being brought up to date in regard to the subjects of which our present knowledge is substantially the

result of research maturing within the last thirty years. This task could not have fallen into hands more capable or more sympathetic than those of Dr. Crooke, the leading authority upon the ethnology, folk-lore, and historical literature of Upper India. He deals faithfully, as he was bound to do, with his author's too facile endorsement of the authenticity of bardic effusions, as with his frequent and rash pursuit of analogy—that Will-o'-the-Wisp of anthropological and linguistic research. He is careful to point out, however, that Tod was here not sinning against the light of his age, and refers to questions of far-reaching importance on which his author was the first to form, or at least to indicate, conclusions which modern investigation has amply confirmed—for instance, the Scythic origin of the leading Rajput clans, and, again, the contrast between the beliefs of the Hindu masses and those of the Brahmans. Dr. Crooke does full justice, as is to be expected of him, to the vivid descriptions Tod gives of the chief religious festivals and ceremonies of Rajasthan, with the tradition of their respective origins, and dwells upon the unique value of the picture here given of a state of society which, within a generation or two after he had placed it on record, had passed away. In conclusion, the editor deserves commendation for the tactful way he has interpolated unobtrusively his numerous essential corrections and additions, without interfering with the enjoyment of his author's more voluminous footnotes. In this way, and by his scholarly introduction, he has gone far to add a new lease of popularity to what he entitles justly the most comprehensive monograph ever compiled by a British officer, describing one of the leading peoples of India.

J. A. B.

The Diary of a Sportsman Naturalist in India.— **E. P. Stebbing.** Pp. 298 + xvi. *Illustrations.* London: John Lane. 1920. £1 1*s.* 0*d. net.*

This is a volume of rambling reminiscences of many years' big-game hunting in Indian jungles. Mr. Stebbing has a lively style which makes his volume good reading, and he is well versed in his subject and has a genuine love of the wild life whose ways he faithfully records. To a sportsman the book will be enthralling from cover to cover, but the naturalist also will find much to interest him. The chapters on jungle lore are of special value. The last part of the book is devoted to questions of game protection and the provision of sanctuaries for the preservation of the Indian fauna. Here Mr. Stebbing takes a wide outlook, and pleads not only for animals of sporting and economic values, but also for the fauna generally. He discusses at length the scanty measures that have been taken locally and the Indian Wild Birds' and Animals' Protection Act of 1912, which he shows is woefully deficient in its scope and powers. The greatest enemy of wild life in India is the native poacher, whose diabolical ingenuity Mr. Stebbing describes. The law at present seems to have little power to touch him. To save many large and small forms of animal life from extinction permanent sanctuaries are required. Areas of primeval forest untouched by man must be left in their original condition. The depredations of sportsman and native poacher and even the felling of trees or other waste must be prohibited if these sanctuaries are to fulfil their purpose. Some excellent photographs and many thumb-nail sketches add to the interest of the book.

R. B.

The Harvest of Japan.— **C. Bogue Luffmann.** London: T. C. & E. C. Jack, Ltd. 1920. 12*s.* 6*d. net.*

This book is a volume of very unequal value, its chief recommendation being the interesting information gathered by the author with regard to such

topics as the dwarf trees and gardens of Japan. Apart from that it need hardly be regarded as a serious contribution to our knowledge of the country with which it deals.

Inaccuracies abound on almost every page, and we sometimes wonder how far its author expects to be taken seriously. Indeed, one is at times inclined to suspect that 'The Harvest of Japan' which he offers us is mainly composed of chaff. He tells us, "I am a traveller . . . out with strange gifts, offering surprises, out to make discoveries." Surprises we are certainly provided with when we are told that "the Japanese are as amphibious as fish"; "laughter is a comparatively modern accomplishment"; "Modern schools! . . . Fool factories, that is what I call them." His strangest "discovery" of all is that "The Japanese claim they are derived from the Ainu," a statement the exact contrary of the fact. Perhaps we may fitly close this notice with the writer's own query, on the last page but one: "If in some of these pages there is more of the writer than of Japan, may I not ask, 'Is not the traveller the thing'?"

W. W.

AFRICA

An Introduction to the Geography of Sierra Leone.— H. Michell. Freetown. 1918. Pp. 128. *Maps.*

This small book has been written by an official in the Education Department in Sierra Leone for teachers in the country. It contains a great deal of information set forth on the whole in a true geographical spirit, but the treatment of towns is a little reminiscent of a gazetteer. There are numerous excellent maps, but the book lacks an index. If this volume has wide use geography should be well taught in Sierra Leone, even if rather local in its scope.

R. B.

A Naturalist on Lake Victoria: with an Account of Sleeping Sickness and the Tse-tse.— Dr. G. O. Hale Carpenter. London: T. Fisher Unwin. 1920. 28*s.*

This is a very valuable contribution towards the solution of the problems concerning the distribution of germ diseases by tsetse flies; together with studies of mimicry in the coloration of insects, especially the polymorphic mimetic butterflies. The scene of Dr. Hale Carpenter's studies was the Sese archipelago of islands which follows an almost parallel direction with the mainland coast of the Victoria Nyanza in the north-west and north. These Sese islands—there is no need for the double *s*—seem to be the vestiges of a former right bank of the infant Nile (known to us as the Kagera), before the vast expanse of the Victoria Nyanza was formed. At the present day there is a perceptible current passing between the coasts of Buganda and the Sese islands which continues to the outlet of the Nile at the Jinja falls.

These islands, together with Buvuma near the Napoleon Gulf, became much associated with the terrible outbreak of sleeping sickness which, beginning in 1901, carried off thousands of the Baganda population and led in fact to the virtual extermination of the Basese, an interesting folk inhabiting this archipelago and speaking an archaic Bantu language. The Sese islands also were the home of a marsh-dwelling aquatic Tragelaph, originally discovered by Captain Speke. This long-hoofed relation of the Kudus and Bushbucks nourished in its blood not merely one but two of the Trypanosomes that are the cause of sleeping sickness and allied diseases fatal to goats. The tsetse fly acts as the intermediary for the distribution of these fatal trypanosomes, not only from the blood of this Tragelaph (*Limnotragus spekei*), but from that of

other antelopes. The blood of the crocodile, so often sucked by tsetse flies, seems to contain only a trypanosome of a harmless nature.

The author does not seem to favour the extirpation of Speke's Tragelaph or of other antelopes as a means of putting an end to the sleeping sickness. He prefers the institution of measures for the extirpation of the tsetse fly. This he maintains can he done by inducing the fly to deposit its pupæ in prepared places and then digging them up and destroying them. The tsetse, like some other insects and certain fish and reptiles, is an anticipation of the Mammalian plan, in that it does not lay eggs but hatches the egg within the body cavity, feeds the fœtus on special juices, and then extrudes a larva which it pushes into the soil to continues its growth as a chrysalis.

The studies of monkeys and their sound-language, of birds, butterflies, fish, and other creatures found on these islands or in their surrounding waters are among the most original and interesting additions to our knowledge of African natural history I have read. This is really a very valuable book. If our British Academy had any life in it or any interest save in rather useless *belles-lettres*, it would crown such a work for its interest as well as its practical value.

H. H. JOHNSTON.

Among the Ibos of Nigeria.— G. T. Basden, M.A., F.R.G.S. London: Seeley, Service & Co. 1921. 25*s. net.*

This well-illustrated book gives an interesting account of the life and customs of the Ibo by a missionary of twenty years' service, and it will prove of value alike to the ethnologist and geographer. The main part of the Ibo country roughly lies between the Niger and Cross river from the coast to 7° N. lat. The southern portion is a typical tropical delta area, with rank vegetation and a humid, enervating atmosphere. The greater part of the interior is hilly, with a vegetation chiefly of scrub and jungle grass and patches of moorland, the red soil sandy and of poor quality for agricultural purposes. On the western side of the Niger the land is at a lower level, much more fertile, and a large part is covered with forest. Game is scarce, and elephants, once abundant, are now almost extinct. In the eastern districts the natives are inclined to be thin and scraggy, but in the west they are shorter and thick-set. There is a great range of skin-colour. On the left bank of the Niger society is chiefly constructed on patriarchal lines, each town and family being independent, and, with the exception of the king of Onitsha, there are no kings; on the opposite side of the river native rule is maintained by kingly authority. The Ibo are a sober people, and do not brew any intoxicating liquor; but drunkenness is on the increase, brought about entirely by the introduction of foreign spirit. In the south, human flesh was a marketable commodity and a common article of diet. The dry season is devoted almost entirely to leisurely pursuits; it is also the time when the young men start raiding and fighting. With the approach of the rains a truce is declared, both parties recognizing the obligation to attend seriously to farming. A month of steady work brings the farm into order; but the women are expected to do most of the weeding. The heavy work of puddling clay for housebuilding is the work of the men. Every free-born youth on arrival at puberty becomes a recognized citizen, and is bound to bear his share in all that pertains to the welfare of his tribe in times of peace and war.

Yams, though singularly deficient in nutritive value, form the staple and favourite food; tradition says that they were introduced by the Portuguese. In comparison with the yield, their production entails a large acreage and strenuous and continued labour; were it not for intermediate crops of maize

and beans and a subsequent catch-crop of cassava, it is doubtful whether yams would repay cultivation. Possibly other products will be grown which will be more profitable and can be exchanged for imported foodstuffs. It is interesting to note that the self-sown oil palms go with the land when it is transferred by purchase, but coconut palms remain the property of those who planted them. In the chapter on trade and currency we read that in the south and east there was a strong demand for manillas and brass rods; in the north and west cowries were, and still are, the most popular form of currency. For facility of trade the introduction of a metal currency is a great boon to the white trader; but many natives refuse to sell at all except for cowries, and it will be a long time before they are finally displaced by a metal coinage unless forcible measures be taken. Mr. Basden points out that the whole political economy of the country is passing through a great transition stage. A. C. H.

AMERICA

In Lower Florida Wilds.— C. T. Simpson. Pp. 404 + xvi. *Illustrations and Maps.* New York: G. P. Putnam's Sons. 1920. $3.50.

Over twenty years of observation in Lower Florida have enabled Mr. Simpson to write a charming volume on the natural history and physical geography of that region, including the Florida Keys. The wild fauna is rapidly disappearing as the tide of population flows southward and the forests are cut down, the streams dredged, and the swamps drained.

MATHEMATICAL GEOGRAPHY

Mapping from Air Photographs.— [Lieut.-Col. M. N. MacLeod, D.S.O.] Issued under the authority of the General Staff, War Office, London: Published by His Majesty's Stationery Office. 1920. Foolscap Folio. Pp. 66. *With Plates. Price 4s. net.*

This excellent publication deals in detail with the methods of mapping from air photographs of which a summary was given by Colonel MacLeod in the *Geographical Journal*, 53, 382. It is stated rather inconspicuously on the second page of the cover that the work "has been compiled by Lieut.-Col. M. N. MacLeod, D.S.O., M.C., R.E.," but it seems to us that the word "compiled" hardly does justice to the merits of the author, who is not only responsible for devising the best procedure of any Field Survey Battalion on the Western Front, but was able in the comparative leisure of the Army of Occupation on the Rhine to ponder the theory, and devise the improved apparatus here first described.

The theory of the rectification of photographs that should have been taken vertically, but are really tilted several degrees in an unknown direction, involves propositions in the theory of perspective which are not readily accessible in convenient form. Colonel MacLeod has done excellent service by thinking them out and bringing them together in a style which is probably as clear as can be attained in this somewhat forbidding subject; forbidding at least until one begins to handle the apparatus and the photographs, when it soon becomes fascinating. Without a clear appreciation of these propositions it is impossible to make any progress either in method or design of instrument: either in development of the camera lucida, which has certain good points, though it is not likely to survive, or in the construction of the photographic "rectifier," which embodies some curious properties of the lens with a flat field that have only recently been brought to light. At least, we do not remember that it was

ever demonstrated in the textbooks of optics that two planes inclined at any considerable angle can be made optically conjugate, one the image of the other and in sharp focus, by suitably disposing a lens of any focal length ; yet the theory, developed on page 47, is quite simple, and the practical consequence is surprising. A photograph of flat country taken at any angle from the vertical can be re-photographed with any lens giving a good flat field, into a rectified photograph such as would have been obtained with a vertical camera. We believe that the proposition was first employed by the late Captain Scheimpflug of the Austrian army, but his exposition so obviously claimed too much for the application of his method that it rather bred suspicion, and did not at once obtain the attention it deserved.

The requirements of the design for a copying camera on this principle are lucidly stated by Colonel MacLeod. But we do not think that a complete apparatus has yet been constructed in England, while we should judge that the camera illustrated in Captain Scheimpflug's paper was not adapted for convenient working. We may hope that the newly appointed Air Survey Committee will make it their business to establish a small laboratory, where this and other apparatus required in air survey may be thoroughly tried, especially in regard to rapid and easy adjustment of the distorted photographs to the ruling points.

A quick way of finding approximately the direction and the amount of the tilt is the first requirement in this work. The methods given by Colonel MacLeod are confessedly rather long, and one or two others which the reviewer had the pleasure of discussing with him during a visit to Cologne require a good deal of development, and the construction of a special drawing instrument, before they could be considered more than geometrical curiosities. There is an opening here for the ingenious geometer.

The methods discussed in this paper are suitable for large-scale work, such as trench maps in flat country ; reconnaissance survey on a small scale in a country with few fixed points is treated very summarily ; while the real crux of the problem, the determination of heights and contours, is just touched upon without any working solution being found. One naturally hopes for success from some stereoscopic method, and it is reported that the Germans used a form of the Pulfrich stereocomparator, which is well known to astronomers, though they are not altogether enthusiastic about it. In view of the poor quality of German mapping on the Western Front we may conclude that the enemy did not as a matter of fact get very far with the employment of this instrument. The use of stereoscopic pictures requires that the photographs shall be perfectly matched in intensity, and that the man who works at them shall have a pair of well-matched eyes : astronomers have failed in the latter respect. Stereoscopic methods have been applied with success in the survey at rather close range of steep inaccessible faces photographed from a fixed and measured base ; but the conditions of air survey are so different that it would be rash to assume in advance the success of a method which must be thoroughly investigated.

The General Staff should be congratulated on the printing and production of their recent technical publications. The figures are good, the mathematical printing well done, and the plates excellent. Only the forbidding foolscap size of page remains to remind us of the old Government printer.

A. R. H.

HISTORICAL GEOGRAPHY

Ser Marco Polo: Notes and Addenda to Sir Henry Yule's edition.— Henri Cordier. London: John Murray. 1920. Pp. 161. *With Frontispiece.* 16*s. net.*

The publication of a book by Prof. Henri Cordier which sheds more light on Ser Marco Polo is an important event. A generation ago, when a third edition of Sir Henry Yule's great work was projected, it was realized that his mantle had fallen on the distinguished Frenchman. Not only was the new edition of great value, showing marked progress all along the line, but it was followed up by an equally valuable new edition of 'Cathay and the Way Thither.'

In the work under review, the wise course has been adopted of publishing notes embodying the results of recent journeys by Sir Aurel Stein and others, while all literature bearing on the subject has been carefully examined by the erudite editor. As a result, material for a fourth edition of the 'Travels' has been collected and carefully worked up.

Part of the charm of Marco Polo's description of his travels lies in the number of problems which his usually brief descriptions raise, chief among them being the uncertainty as to the exact routes he followed. This meets us in the opening chapters. Did Marco Polo travel from Ayas to Erzinjan and thence *viâ* Mosul, Baghdad, and Basra down the Persian Gulf to Hormuz, then a port near Minab, or did he follow the land route *viâ* Tabriz, Kashan, Yezd, and Kerman to Hormuz? Again, did he, when travelling northwards from Kerman, visit Tabas or not? Friendly discussions on these questions are always interesting and are frequently fruitful in results. But yet dogmatic pronouncement is to be avoided, and while I hold to the view that Marco took the land route across Persia and did not visit Baghdad, Basra, or the head of the Persian Gulf, I should be unwilling to insist on my view being correct as against Prof. Cordier's, even though Prof. Beazley supports me.

Farther east the journeys of Sir Aurel Stein have made a most substantial addition to our knowledge of the Russian Pamirs, Roshan, Shignan and other petty states, which were sealed books to Yule. We specially note that Stein published a valuable paper on Marco Polo's account of a Mongol inroad into Kashmir in the *Geog. Journal* of August 1919, which added considerably to our knowledge of the subject.

A recent journey across the Pamirs made by Stein in 1915, when I was also travelling in those uplands, makes it clear that the exact route followed by the Venetian cannot be laid down. He evidently avoided the old-established village of Tashkurgan and probably Tagarma. Through inquiries made by me on the spot, I learned that caravans from the Pamirs generally came out at Bulunkul, where the Tashkurgan route meets various routes from the west, and such a line would fit in with the text, but it is impossible to fix the exact route. As to Kashgar, times have changed since Marco described its inhabitants as a wretched, niggardly set of people who eat and drink in miserable fashion. Owing to the construction of the Russian railway system to Andijan, Kashgar is the most prosperous oasis in Chinese Turkestan, and its inhabitants are sturdy and well-mannered peasant proprietors who enjoy plenty of feasting and music. In the onward journey Stein identifies Pein with ancient Kenan and the city of Lop with the present Charklik, and so ever onwards across the Great Desert to China.

Here this review must end, but perhaps enough has been said to show the

importance and deep interest of the work, which will appeal to readers in general and to Fellows of the Royal Geographical Society in particular.

P. M. SYKES.

GENERAL

Letters of Travel, 1892-1913.— **Rudyard Kipling.** London: Macmillan & Co., Ltd. 1920. Pp. 284. *7s. 6d. net.*

This is Kipling at his best giving vivid fresh impressions of America, Canada, Japan, and Egypt. It is one of those rare books, like 'From Sea to Sea,' which is almost an adequate substitute for travel in the reality it gives to unfamiliar lands: perhaps such books are even better than travel, for few can see as deeply and far as Mr. Kipling. The letters are reprinted from various sources, but they can never be out of date. Such a volume of travel permanently enriches our libraries.

Dead Towns and Living Men.— **C. L. Woolley.** Oxford: University Press. 1920. *12s. 6d. net.*

No one, after reading this entertaining volume, can say that the pursuit of archæology is necessarily dull. The author gives a lively account of his observations and experiences incidental to excavations carried out in Egypt and Italy and at Carchemish. The characteristics of the workmen employed and of the native peoples are described and commented on in a sympathetic, acute, and vivacious manner. The account of the Milli-Kurds is particularly interesting. The incompetence and corruption of the Turkish Government and its officials are vividly portrayed, and we can only admire the vigour and success with which Mr. Woolley met and overcame them. His power of gaining the confidence of his workmen on the one hand, and of the unruly Kurds on the other, is a tribute to his insight into human nature and his ability as a leader. His account of Carchemish and the discoveries revealed by the excavations is very clear and informing, is illustrated by a plan and several good photographs, and brings home the reality of the mysterious Hittites in a more striking way than is usual. Archæological excavation, in fact, becomes in the hands of the author a life full of incident and adventure. Mr. Woolley describes his book as "pages from an antiquary's note-book," and it may safely be said that the experiences of an antiquarian explorer are seldom described in so readable and interesting a fashion as they are in these pages. E. A. P.

HISTORICAL GEOGRAPHY

The Story of the Blue Back Chart.— London: Imray, Laurie, Norie & Wilson, Ltd. [1920.] Pp. 20. *Facsimiles.*

In the days of the early British navigator there was no Hydrographic Department of the Admiralty to publish charts for his guidance, and he had to depend upon those issued by private publishers. The history of the production and publication of these non-official charts, so far as this country is concerned, is briefly traced in an interesting pamphlet just issued by the firm of Imray, Laurie, Norie & Wilson, Ltd., illustrated by photographic facsimiles of the titles and title-pages of some of the more important old sea atlases and charts. Attention is first called to the fact that it was to the Dutch that we were chiefly indebted for the charts and sailing directions in use by the British Navy and Merchant Service. In the year 1583 Lucas Jansz Waghenaer published, at Leyden, his work entitled 'De Spieghel der Zeevaerdt," which was copied by Anthony Ashley as the 'Mariners' Mirror.'

Introduced into England, this became known by a translation of the name of its author, and was the first 'Waggoner.' Later on other publications appeared, notably the collection of charts of Van Keulen, which were largely copied for the use of British navigators. It was not until 1795 that the Hydrographic Department of the Admiralty was founded, but when Admiralt y charts appeared they did not wholly supersede those of private nautical publishers, which even now are in considerable demand, especially by officers of the Merchant Service. These non-official navigation charts have become generally known as "blue-backs," since they are usually mounted on blue paper to distinguish them from the official Admiralty publications.

John Seller appears to have been about the first regular chart publisher in this country, and he established himself in the reign of Charles II. at "The Sign of the Mariner's Compass, Hermitage Stairs, Wapping," where in November of 1670 was issued the first part of his famous work 'The English Pilot.' From this early pioneer of British nautical publishers, by purchase and family connection, eventually arose the firm of Laurie, from which by combining and amalgamating with other nautical publishing firms has arisen the present well-known establishment of Imray, Laurie, Norie & Wilson. The history of the different houses constituting this firm is traced separately in the pamphlet now issued, which will be read with interest. Many of the early hydrographic atlases and charts mentioned are of considerable value for historical reference, while such works as 'Norie's Navigation' and 'Findlay's Sailing Directions' have been constantly revised and are still of the greatest service.

The late Mr. D. W. Kettle, for so long connected with this publishing house, bequeathed to the Society a valuable collection of early charts and atlases, published by the different branches and predecessors of the present firm; and it is to Mrs. Kettle, his widow, that we are now indebted for the copy of this interesting little history. E. A. R.

THE MONTHLY RECORD

EUROPE

Supposed Glacial Cirques in the Middle Vosges.

WHILST traces of former glacial action are fairly plentiful in the Southern Vosges, they are extremely scarce in the middle section of the range—a fact which lends interest to a description of various cirque-like forms in the latter section by Otto Jessen in the *Zeitschrift für Gletscherkunde* (Band xi. Heft 3, March 1920). They occur in the "Buntsandstein" region south of the Donon, on the east and north-east slopes of La Max, Le Rond Pertuis, and the Bipierre, and consist of more or less circular niches which break the regularity of the slopes, and greatly resemble ancient cirques. All are very similar, and occur on or near the same geological horizon, viz. the junction of the Vosges Sandstone with the underlying Upper "Rotliegendes" (marked otherwise by the number of springs there issuing). They are placed high up above the valley floors, and are bounded on the upper side by the steep cliffs characteristic of glacial cirques, while on the lower side they are blocked by moraine-like walls of rock fragments. The floor is level and consists of peaty soil, which has evidently taken the place of a former small lake. The basins appear to be of the shape of a shallow cup, but whether they are actually excavated in the rock has not been ascertained. Their origin seems only explicable as due to glacial

agency, and this conclusion is strengthened by their occurrence only on the cool exposure of the range. Other traces of glacial action are wanting, but this may be explained by the easily weathered nature of the rock. The cirques would seem to date from the last phase of the Ice Age, when the ice had shrunk to the extent of a few hanging glaciers, which would naturally be formed in indentations in the mountain-sides, such as occur elsewhere at the junction of the two geological formations named. Though confined to a zone between 620 and 670 metres above the sea, they can hardly give a clue to the former snow-level, as they were probably of local occurrence only, where the conditions were specially favourable. These forms are closely comparable with the much more numerous cirques in the Black Forest, which are also most frequent on the east side. The writer ends with a sensible suggestion that the use of the term "cirque" (Kar of the German-speaking Alps, etc.) should be permitted to include features of similar outward form, even when the mode of formation is not identical. These cirque-like hollows of the Vosges and Black Forest are rather to be ascribed to the removal of detritus by the ice than to any excavating action, which some have sought to make a criterion of a true cirque.

AFRICA

Commandant Audoin's Journey from the Cameroon to Egypt.

Commandant Audoin has long been known to geographers for his hydrographical surveys in French Equatorial Africa and the Lake Chad region. During the war he took part in the military operations in the Cameroon (where he was wounded), and was afterwards charged with inquiries into the possibilities of opening communications between the coast and the French Chad territory through the newly acquired territory of the Cameroon. Last year he returned to Paris after completing an interesting traverse of the whole width of the continent to the Nile and Egypt, passing *en route* some of the least-known districts south of Darfur. Some notes on his journey appear in *La Géographie* for September–October 1920, being concerned chiefly with a discussion of the present economic position in the regions traversed. The journey from Garua on the Benue to Egypt occupied six months, and was made without military escort—an indication of the satisfactory state of security now prevailing in regions only quite lately brought under European influence. After briefly considering the value of the Cameroon territory acquired by France (the northern, Sudanese, portion is particularly favourable for cattle-rearing), the note discusses the possibilities of using a route through the Cameroon for the supply of the Chad region and Wadai. At present it will be necessary still to depend upon the Niger and Benue as a means of access from the sea, though it is hoped to become independent of this alien route in time. For the moment the chief need is the establishment of a French line of steamers on the Benue and the construction of a railway from Garua to the Logone, which will connect the basins of the Niger and Shari, and make of Garua to some extent the maritime port of French Central Africa. In time something may be done to extend the Cameroon railways and improve the system of roads, since the rivers are practically useless for navigation. The notes on the country south of Darfur give useful information on a tract partially known from the explorations of M. A. Chevalier, but lately so harassed by the raids of the Sultans of Darfur, Dar Kuti, and Dar Sila as to be in great part depopulated. Since the establishment, in November 1918, of the French post at Birao, Dar Kara has begun to recover through the influx of people from Darfur, but Dar Kreish (Krej) and

Dar Binga are still without inhabitants. What has been known as Lake Mamun is a vast swampy depression with small patches of water all the year round, and a few villages on spots not covered by the inundations. The country situated between the Mamun and the first dunes of south-west Darfur is inundated in the rains, but in the dry season a waterless desert from which the elephants are forced to migrate southwards. North-east of Dar Kara is Dar Taasha, fairly well peopled by half-sedentary Arabs and rich in cattle. It seems to be mainly on the French side of the boundary (formed south of 11° N. by the Nile–Congo and Nile–Shari water-parting), for Commandant Audoin found that a temporary watercourse, the Toal—a tributary of the Yata and through it of the Shari—cuts 11° N. near the 24th meridian east of Greenwich, thus carrying the Shari basin further east than has been supposed. [The Toal, or Toyal, is shown by report on the Sudan Survey Department map on the scale of 1/250,000, published at Khartoum in 1920, as flowing much as is described by the French traveller, but cutting the 11th parallel somewhat west of the 24th meridian.] The further route led to El Obeid by way of Abu Gabra, one of the lately established British posts in the south of Darfur.

Progress in the Belgian Congo.

The Belgian Minister for the Colonies, in introducing the budget for the Belgian Congo for 1920, spoke at some length of the present economic position in the Colony and its prospects for the future, with special reference to the development of means of communication. An extract from his speech, forwarded by the British Ambassador in Brussels, has been obligingly sent us by the Department of Overseas Trade. The Minister, M. Franck, indulged in an enthusiastic eulogy of the riches of the Belgian colony, which he considers the jewel of Tropical Africa, possessing not only untold mineral and vegetable resources, but an unrivalled system of fluvial transport. He regretted that the development of its resources was left by Belgians more than need be to foreigners. Besides the exploitation of copper, tin, and iron at Katanga, and of gold at Kilo and Mobo, diamonds have been found in the Kasai and Kwango region, and ten thousand workmen are now being employed in their extraction. Attempts are being made to educate the natives to take an active part in their own administration. Referring to the transport question M. Franck said that at present the roads were not good, but it is proposed to improve them after the model of the British East African possessions. Tonnage for river transport is not yet sufficient for the amount of merchandise, but progress has lately been made through the enterprise of the National Society of River Transport. The railway system (which, in conjunction with the river navigation, supplies communication with the Upper Congo, Rhodesia, and other parts of South Africa, and with the east coast *vid* Ujiji and Tabora) is also being extended. The most important line—that from Matadi to Leopoldville—is still inadequate to meet the requirements, though its capacity has been increased by the supply of new rolling stock. A new line has however been traced between the terminal points, which will have the advantage over the existing line in its avoidance of steep gradients and sharp curves. Four mail steamers now run between Antwerp and Matadi, and four cargo boats have lately been purchased.

AMERICA

The Northern Appalachian Coalfield.

In 1912 the United States produced something over one-third and Great Britain something over one-fifth of the World's output of coal. If we take as

unit 100 million short tons, the United States' share was 5 units, and of these 3¼ came from one great coalfield, and 2½ from a single State in that field—Pennsylvania. With these striking facts Mr. P. W. Bryan begins an instructive article on "Some Geographical Factors in the Northern Appalachian Coalfield" in the *Scottish Geographical Magazine* for 15 October 1920. They are sufficient to show the importance of the Pennsylvanian coal to the world's economy at a time when the British coal industry is passing through the most critical stage in its history. Mr. Bryan shows a full understanding of the geographical factors at work in Pennsylvania as well as of the statistics of recent production, and he gives a well-digested summary, bringing out the whole position at a glance. The Appalachian coalfield forms a great belt from Pennsylvania to Alabama, lying to the west of the Allegheny Front by which the westward-sloping plateau falls abruptly eastward to the "Great Appalachian Valley" (in reality a complex of parallel ridges and furrows). Structurally the plateau consists of a series of low broad synclines and anticlines, while the ridges and furrows to the east are the result of intense folding and crushing of the strata against the old continent of Appalachia. After being worn down by erosion the plateau was uplifted, with the result that the rivers dug out deep trenches which to-day play an important part in the industrial development of the region. The rocks are mainly massive sandstones and limestones of Carboniferous age containing several coal-seams, of which the most important is the famous Pittsburg bed. The shallow synclines have preserved the coal at no great distance from the surface, while the low anticlines bring it still nearer the surface, and where their summits have been planed off it outcrops on either flank. The main producing area in Pennsylvania lies east and south of Pittsburg, but the coalfield extends westward into Ohio and southward into West Virginia. Pittsburg owes its importance to its position as the focus on which various river valleys (of the Allegheny–Ohio system) converge from the south-east, giving a down-grade for all coal moving north-west. Thanks to the cutting down of the river valleys the mines are strung out in long lines along the streams. The coal lies nearly horizontally over large areas and is of very uniform thickness, making possible the use of coal-cutting machinery on a large scale. Rather more than half the coal is obtained from "drifts" driven in from the river-bank by an up-slope so that it can be run by gravity to the water-side: when obtained from a down-slope mechanical power is needed to raise it. Vertical shafts are also in use, but the depth is so moderate as to greatly reduce the cost of raising as compared with that entailed by the deep shafts of this country. The old terraces in which the rivers are now entrenched provide excellent sites for mining communities, and facilitate the use of the valleys for railway routes. The coal is of a high-grade type, and the coke from the Connesville district is the standard blast-furnace fuel of the United States. Besides being used locally for the Pittsburg iron industries, it is sent to other parts in large quantities, though of late there has been a tendency for the coal to be sent away as such, to be made into coke where required. Mr. Bryan discusses the effect of geography on the transport routes to the north and east, those in the latter direction being governed by the breaches made by the rivers in the ridges of the Great Valley. Those from the Pittsburg district connect with the northern tide-water ports—New York, Philadelphia, and Baltimore, while the West Virginia fields are linked with Newport News and Norfolk. As against all the above advantages, the only important disadvantage from which the United States suffers from the point of view of export is the distance of her coalfields from tide-water.

Swedish Explorations in the South American Cordilleras.

A Swedish scientific commission under the leadership of Professor Otto Nordenskjöld, and with Mr. A. Bäckman, geographer, and Count S. de Rosen, zoologist, as its other members, left Sweden in June 1920 with the special aim of studying some little-known regions in the Central and Southern Cordilleras. In Peru the Government immediately put ample means at the disposal of the expedition, and appointed a commission under the leadership of Dr. Carlos Rospigliosi Vigil, director of the Natural History Museum in Lima, and well known for former explorations in the Peruvian forest region, to co-operate with the Swedish scientists. During the months August to October this expedition studied more especially the glacial features of the Sierra region south of Oroya, and then, in rafts navigated by Indians of the Campa tribe, descended the river Perene, which has never before been explored scientifically, to its junction with the Ene, returning by the Pangoa valley, also very little known. Here fossils were found in several places ; and the studies of the structure and topography of the eastern forest-clad slopes of the Cordillera, as well as of the ethnology of the Indians, will be of interest. From Peru the Swedish party, which was now joined by Captain N. H. Pallin, proceeded to the south of Chile. Here the Government put a small steamer at its disposal for the voyage, and with this the members were at the middle of December on their way to the Peñas Gulf, their principal object being to study the region round the well-known San Rafael Lake, and if possible to ascend by one of the glaciers to the inner mountain region and to study the extensive so-called inland ice, which has never before been visited in this its northern part. The commission expects to return to Europe at the end of the southern summer.

AUSTRALASIA AND OCEANIC ISLANDS

Limestone Resources of New Zealand.

Fertile as is the greater part of New Zealand, this fertility can only be maintained by the judicious use of fertilizers, of which lime is perhaps the most generally important. An elaborate study of the resources of the Dominion from this point of view, as well as the almost equally needed phosphate resources, has been made under the auspices of the New Zealand Geological Survey, and the results as regards lime have been published in *Bulletin* No. 22 (N.S.) of the Survey, the author being the Director, Mr. P. G. Morgan. The Memoir begins with a chapter summarizing the uses and importance of limestone and lime, the methods of exploitation and transport, mode of occurrence, and so on, from a general point of view, with no special reference to New Zealand. The two other chapters deal respectively with the North Island, and the South Island and dependencies, taking each separate county in order, and discussing for each the limestone resources (if any) and the transport facilities, including those for import of lime from outside where no local resources are available. The writer makes no attempt to summarize the conditions for New Zealand as a whole ; possibly this will be done in the second part of the Memoir. There are two large-scale maps showing the limestone localities. Few of the counties are without some resources, though their extent and character differ greatly, as do the transport facilities for introducing supplies from outside. Of Whangarei County in the North Island, we read that "not only has it numerous deposits of high-grade stone suitable for calcination, but it has immense quantities of argillaceous limestone suitable for application to the soil after pulverization, and eminently adapted for the manufacture of cement. Many of the deposits

are close to a railway or to deep water. . . ." Waitomo County "is well provided with limestone of the highest grade." In Collingwood County (South Island) "there are enormous quantities of high-grade stone, suitable for agricultural purposes, for building, and for use as a flux for the iron-ore south of Parapara Inlet . . . Pure magnesian limestone and dolomite occur in unknown amount north-west of Collingwood." Tertiary limestone seems to be unlimited in quantity, but is not as a rule high-grade. Unfortunately the mountainous nature of the county impedes internal communications, but Golden Bay may be regarded as potentially a good port. Waitaki County, again, "contains great quantities of high-grade limestone, favourably situated for being worked." These are examples of counties with good resources, but there are others with little or no supply and badly situated for obtaining lime from elsewhere. The monograph gives details throughout of the geological features and references to previous literature.

The Climate of the Falkland Islands and South Georgia.

In *Geophysical Memoir* No. 15, of the Meteorological Office, we have a discussion by Mr. C. E. P. Brooks of the "Climate and Weather of the Falkland Islands and South Georgia," chiefly on the basis of some ten years' observations between 1905 and 1915. The Falkland Islands in climate and scenery much resemble some of the outer isles of Scotland, like the Orkneys and Shetlands, and indeed are populated mainly by shepherds of Scottish origin. As the Falkland group is bathed by cold ocean drift instead of warm, the mean annual temperature is about 7° lower than that of the south of England in a roughly corresponding latitude, and about 2° lower than that of the Orkneys or Shetlands, which lie 10° farther from the equator, and have a similar damp and cheerless climate. At Cape Pembroke the ten years' record indicates a mean temperature of only 42·9° F., ranging between 36·7° in July and 49·3° in January, the corresponding figures for London (interchanging January and July) being 49·6°, 38·8°, and 62·7°, which show that the Falklands are much colder in summer but only a little colder in winter. At Stanley the average annual rainfall is about the same as London's, 25 inches; but it is pointed out that the amount must be much greater on the exposed western coasts, and among the highlands of the interior. South Georgia lies somewhat farther south, and is highly mountainous with peaks up to 8000 feet, so that there conditions are more decidedly "sub-arctic," with large glaciers and a permanent snow-line on the western side as low as 2000 feet. On the north-east side föhn winds to a large extent prevent accumulations of snow. At Grytviken, South Georgia, the mean temperature is lowest (27·9°) in July and highest (43·5°) in February, and the annual precipitation amounts to about 56 inches. The climate of the Falkland Islands is not unhealthy, but the almost constant high winds are very trying, especially as they prevent the sunshine of summer from ever producing anything approaching a hot day, the temperature barely exceeding 60° F. on some four days in the year. The number of days with frost and snow in the Falkland group (without South Georgia) is rather large. It would seem that the climate of the Falklands in their isolation from great land masses is even more monotonous than that of the Scottish islands, which owe their greater variety to proximity to larger land-areas. The statistics quoted for the frequency of gales in Falkland are interesting in that they do not show that marked concentration of storms into mid-winter which is such a striking climatic feature of the North Atlantic.

POLAR REGIONS

Mr. Cope's Journey to the Antarctic.

In the *Journal* for April last we published the statement that this Society was unable to approve of the plans or the leadership of Mr. J. L. Cope, or to give his proposed expedition to the Antarctic its countenance and support. Nevertheless there have been during the last few months some references in the newspapers, especially American, to the "British Imperial Antarctic Expedition," as having the support of the Society. Other and more numerous accounts refer to the Polar Research Institute and the University of Cambridge as the sponsors of the expedition.

A typical newspaper story is that of the *New York Evening Post* of 11 December 1920, from which the following extracts are taken:

"Perhaps the largest exploring expedition now on its way, certainly the largest of its kind ever organized in England, and the one from which the greatest results are expected, is the British Imperial Antarctic Expedition, under the leadership of Commander John Lachlan Cope, F.R.G.S., formerly of the Royal Navy, who accompanied the last Shackleton expedition as surgeon and biologist to the Ross Sea Party.

"Dr. Cope plans to circumnavigate the Antarctic continent, and to spend five years in the work. . . .

* * * * * * *

Cope's Fleet of Ships.

"His ship, the *Thor I.*, sailed from England on September 28 last, and from Norfolk, Va., where Dr. Cope joined her, on December 26. She was to touch at Montevideo and then go to Deception Island in the Falklands, where moving pictures will be made of the whaling industry. Late in October a second ship left Cardiff, Wales, for the Falkland Islands. Three whalers of 7000 tons each and one whale catcher of 200 tons will accompany the expedition.

"Associated with Dr. Cope on the expedition are N. G. Lester, navigator; Thomas W. Bagshowe, geologist; Captain George H. Wilkins, chief of scientific staff (he accompanied the Stefansson expedition in the same capacity); and 120 men.

* * * * * * *

"The total cost of this expedition is estimated at about $750,000. It has the backing of the Royal Geographical Society and other British scientific bodies, besides that of the Imperial Government and the Governments of Australia and New Zealand."

* * * * * * *

The facts underlying the above are that Mr. Cope and members of his small party have been given by Mr. Lars Christensen a passage to the South Shetlands in ships of the Norwegian whaling company. They were to be joined in Montevideo by Captain Wilkins, and expected whalers to land them somewhere about Hope Bay in order that they might make a journey down the western coast of the Weddell Sea.

In view of possibilities it is desirable to repeat for public information that this self-styled "British Imperial Antarctic Expedition" of a few men is not in any way whatever approved or supported by the Royal Geographical Society, nor by the Polar Research Institute, nor the University of Cambridge. The party owe much to the liberality of the Norwegian whalers, and particularly to Mr. Lars Christensen, and it is due to him that the enterprise should be viewed in its proper perspective.

GENERAL

The Oil Palm as a Plantation Crop.

The latest issue (1920, No. 2) of the *Bulletin of the Imperial Institute* contains an interesting article on the African Oil Palm, its uses and cultivation.

As is well known, the industry maintained by the products of the oil palm is one of the most important in West Africa, particularly Nigeria, where such products form a large proportion of the exports. They consist both in the oil obtained from the fleshy pulp which surrounds the nuts (used in Europe very largely for the manufacture of soap and candles), and in the kernels themselves, the oil of which is largely employed for making margarine. Hitherto this industry has depended on the produce of palms growing wild in the West African forests, but trials have of late been made in the cultivation of the tree in plantations. Success has already been obtained in Sumatra and other parts of the Malay region, and it is expected that the oil palm will become a plantation crop of great importance in the Eastern tropics. It is considered that so cultivated it may yield larger profits than the coco-nut palm.

Erratum: Mount Everest Discussion.

In the report of Mr. Freshfield's speech, p. 17, line 5 from bottom, for *ice* read *air:* the mis-report made the speaker refer to the "erosive action by water and ice," which not only contradicted the first part of the sentence on "glacial protection," but was opposed to the whole sense of the argument.

Erratum: Spelling of Geographical Names.

An accident which occurred in printing the January *Journal* illustrates one of the difficulties confronting the P.C.G.N. When passed for press the table of the R.G.S. II. system contained three vowels with the diæresis; early in the course of printing two of the three, the *o* and the *u*, lost the two dots from above them, and the table became badly wrong. Such accidents must often defeat the best intentions, until British printers can complete their founts by the addition of letters with the diacritical signs properly cast.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1920–1921

Fourth Evening Meeting, 20 December 1920.—The President in the Chair.

ELECTIONS.—Gordon Hooper Brown; Harry Cox; Colonel K. S. Dunsterville, C.B., I.A.; Harold B. Foster; Lady Goold-Adams; Captain Harry Jones; The Rev. Duncan R. Mackenzie; Colonel C. S. Meeres, C.B.E., R.A.; Captain E. C. Mogridge; Miss B. Ommanney; Captain John Monkhouse Orwin; Major George Meredith Sanderson, M.R.C.S.; Frederick Lumley White; Allan Wilen; Major Hubert Francis Wilson, M.C.

PAPER: The Future of Polar Research. Mr. Frank Debenham.

Fifth Evening Meeting, 10 January 1921.—The President in the Chair.

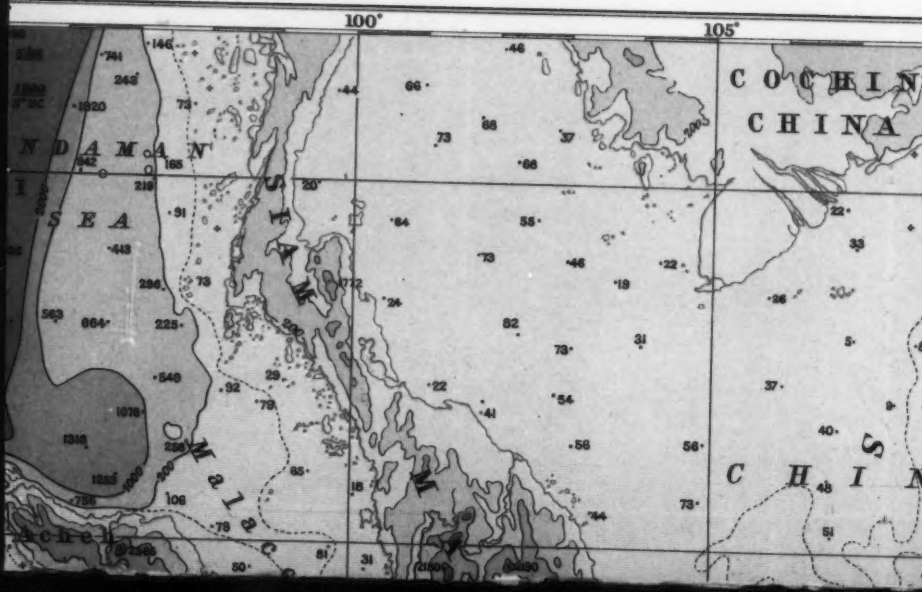
ELECTIONS.—Mrs. Thomas Alexander Baggs; Thomas Richard Byers; P. Betton Done; The Rev. William Haddow, B.A.; The Ven. Archdeacon Leonard Rhys Hancock; Edgar Chignell Harwood; Prince Charles Hopkins; Motoichi Ikegami; Robert Henry Kinvig; Teisaburo Kuga; Bernard Lockey; Patrick William Mactavish; Edward Geoffrey Payne; Charles James Perkins; Lieut. C. W. Seymour-Hall; Bernard Siffken, B.A.; Kusuo Tida; Captain H. H. Wilkinson, M.A.; George Wishart.

PAPER: A Reconnaissance in the Caspian Provinces of Persia. Captain J. B. L. Noel.

Third Afternoon Meeting, 17 January 1921.—The President in the Chair.

PAPER: International Aeronautical Maps. Lieut.-Colonel E. F. W. Lees.

DEEP SEA BASINS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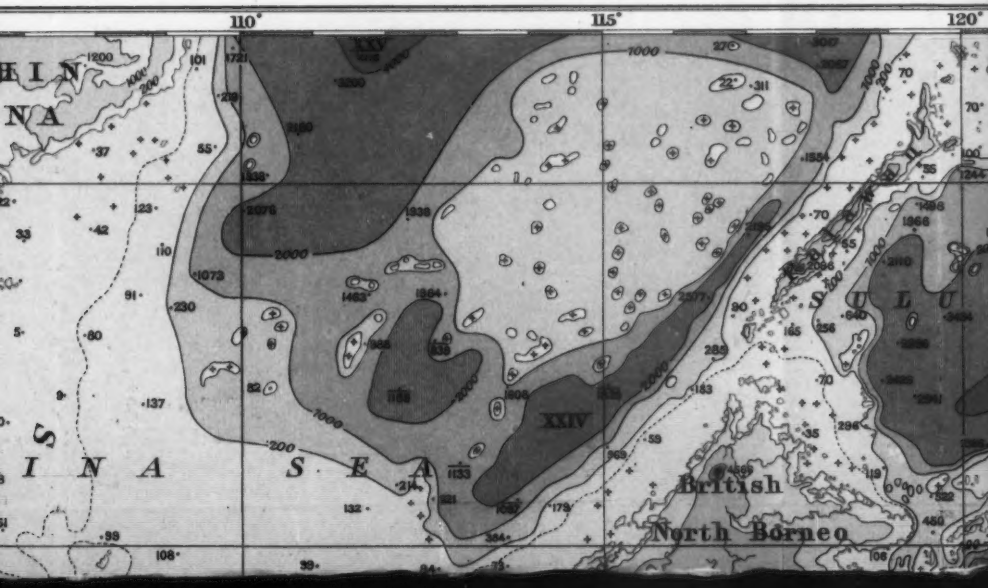

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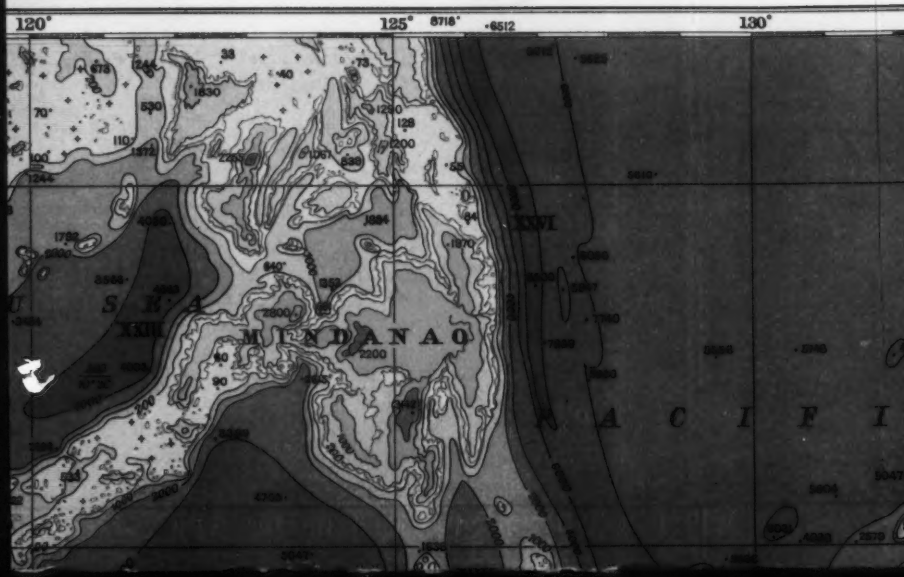

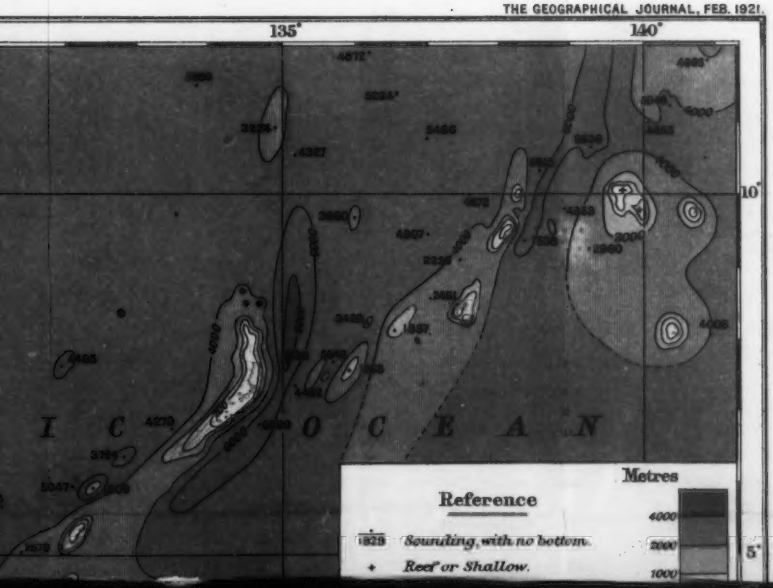
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DEEP SEA BASINS

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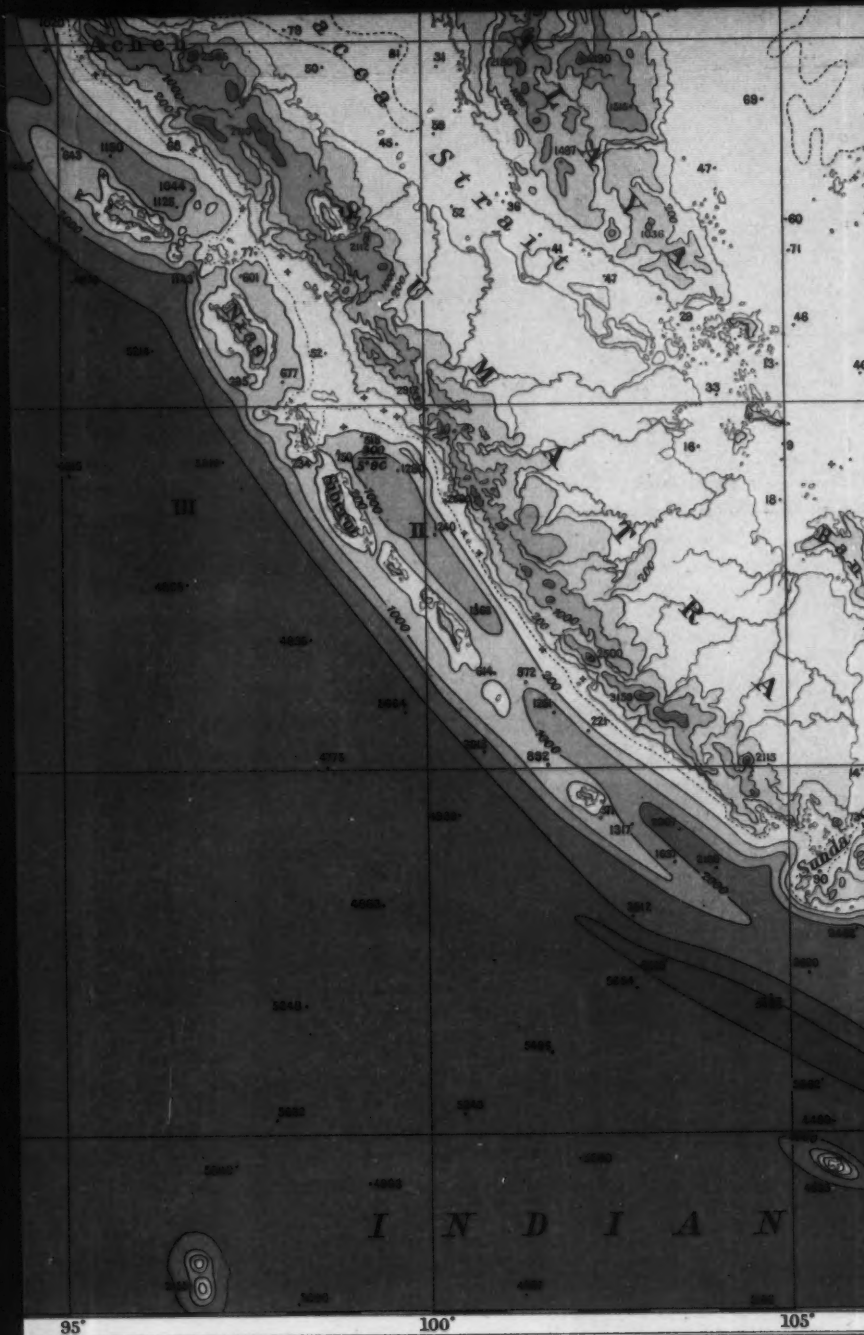
III. Mentawei or Sunda Trough
IV. Java Trough
V. Timor Sea
VI. Kei Trough
VII. Ceram-Aru Trough
VIII. Flores Sea
IX. Savu Sea
X. Wetta Trough
XI. Saleyer Trough
XII. Buton Trough
XIII. Kaiao Trough
XIV. North-Western Banda Sea
XV Central Banda Sea
XVI. Eastern Banda Sea and Weber Deep
XVII. Batyan Trough
XVIII. Gorontalo Trough
XIX. Sangir Trough
XX. Togean Basin
XXI. Tomini Basin
XXII. Celebes Sea, including Strait of Makassar
XXIII. Sulu Basin
XXIV. Palawan Trough
XXV. South China Sea
XXVI. Mindanao Trough
XXVII. Halmaheira Basin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Published by the Royal Geogr

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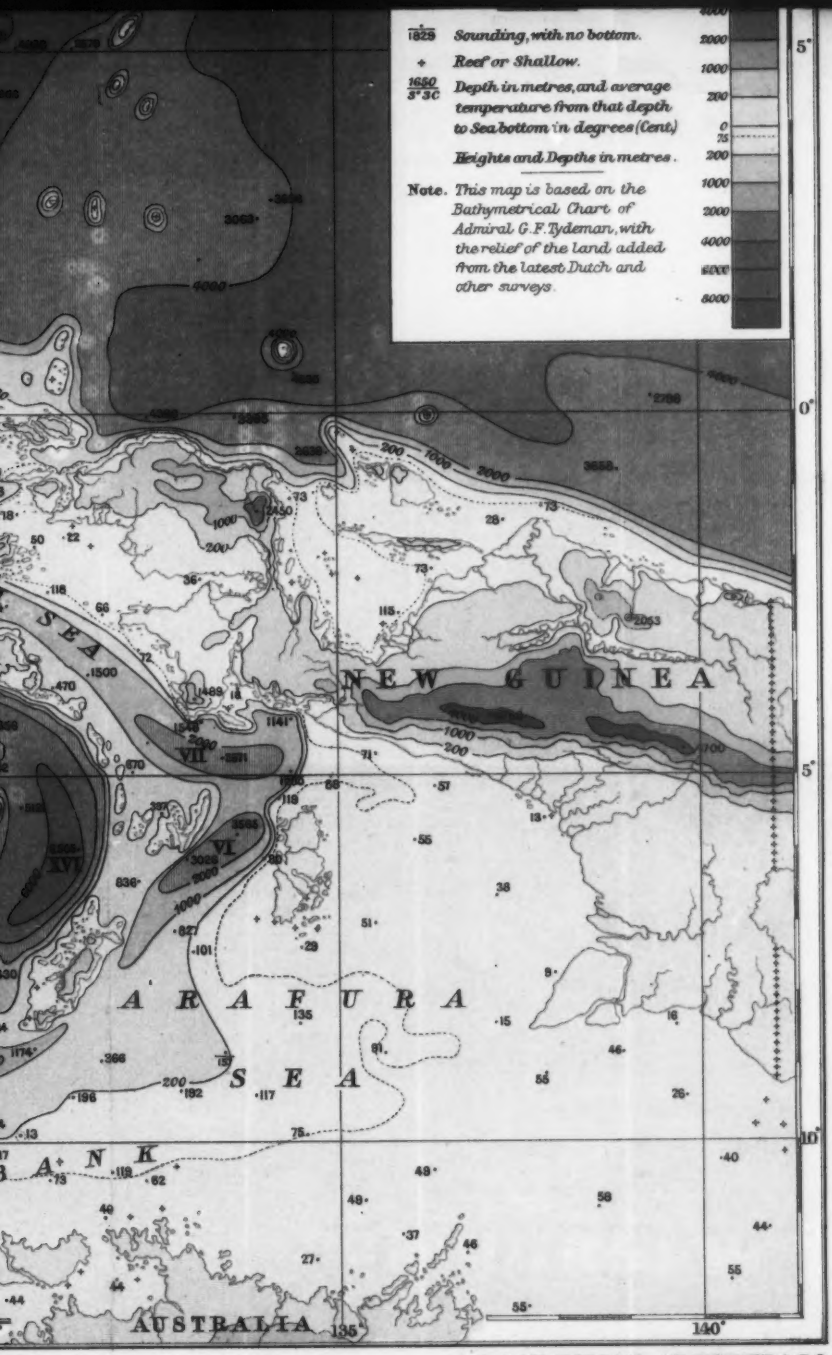

EAST INDIAN ARCHIPELAGO
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